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PERFORMANCE INNOVATION LABORATORIES

**VIBRATION TESTING REPORT
FOR CRANE**
TOL0901051

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Date: September 17, 2009

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Date: September 17, 2009

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Revision History

Revision	Created by	Date	Short Description
1	Dominic Sgro	July 30, 2009	Initial Version

EXECUTIVE SUMMARY

A board-level vibration test was performed on NASA DOD LFE / Crane Lead-free and Reworked-Mixed (leaded/lead-free) Circuit Board Assemblies. The testing followed the document specifications titled "NASA-DoD Lead-Free Electronics Project JTP" supplied by Andrew Ganster. Nine assemblies in all were tested. Each board was monitored for vibration response and net resistance for all 63 components. The assemblies were attached to the table with the supplied test fixture. Each sample was subjected to the stated random profiles starting at 8.0rms for 1 hour duration in the Z axis to the assemblies. Input levels increased by 2Grms with 1 hour duration at each step up to 20Grms. A final 28Grms profile was conducted for 1 hour. The vibration response levels for each card at each input level were recorded along with any resistance events during the vibration. Results of the tests are found in section 6 below.

The physical failure analysis results will be provided in a separate report.

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1. PRODUCT INFORMATION

Products Under Test	Lead-free and Mixed-Reworked (lead/lead-free) Circuit Board Assemblies
Quantity Provided	9
Serial #'s	61, 62, 63 64, 65, 66 67, 68, 79

2. TEST SPECIFICATIONS

Name	Reference #	Level/Control
NASA-DoD Lead-Free Electronics Project JTP		Oct 08 2007

3. INSTRUMENTATION

Description	Serial Number	Calibration Due Date
LDS V894 Shaker with slip table	SP5302-001/1	N/A
Spectral Dynamics SD2560 Vibration Control System	1352	07/28/2009
LDS CA4 Charge Amplifier	C0010589	09/17/2009
LDS CA4 Charge Amplifier	C0010615	09/07/2009
Control Accelerometer: Unholtz-Dickie 10B10T	5644	09/23/2009
PCB P356A08 Auxiliary Accelerometer	20456	11/19/2009
PCB P356A08 Auxiliary Accelerometer	20459	11/19/2009
PCB P356A08 Auxiliary Accelerometer	13707	11/19/2009
PCB P356A08 Auxiliary Accelerometer	13708	11/19/2009
PCB P356A08 Auxiliary Accelerometer	13849	10/28/2009

4. ANALYSTS

Name	Employee #	Title
Dominic Sgro	07020163	Mechanical Stress Specialist

5. RANDOM VIBRATION TEST PROCEDURE

As requested by Crane, the following was performed on the test units:

- 9 cards in total (see **Section 8: Appendix A** for test setup photos)
- Each card monitored for vibration response (See **Section 9: Appendix B**)
- Each card monitored for resistance (see **Section 6** for components and results)
- Each card subjected to the profiles below (Fig 1, Table 1)for one hour at each level:

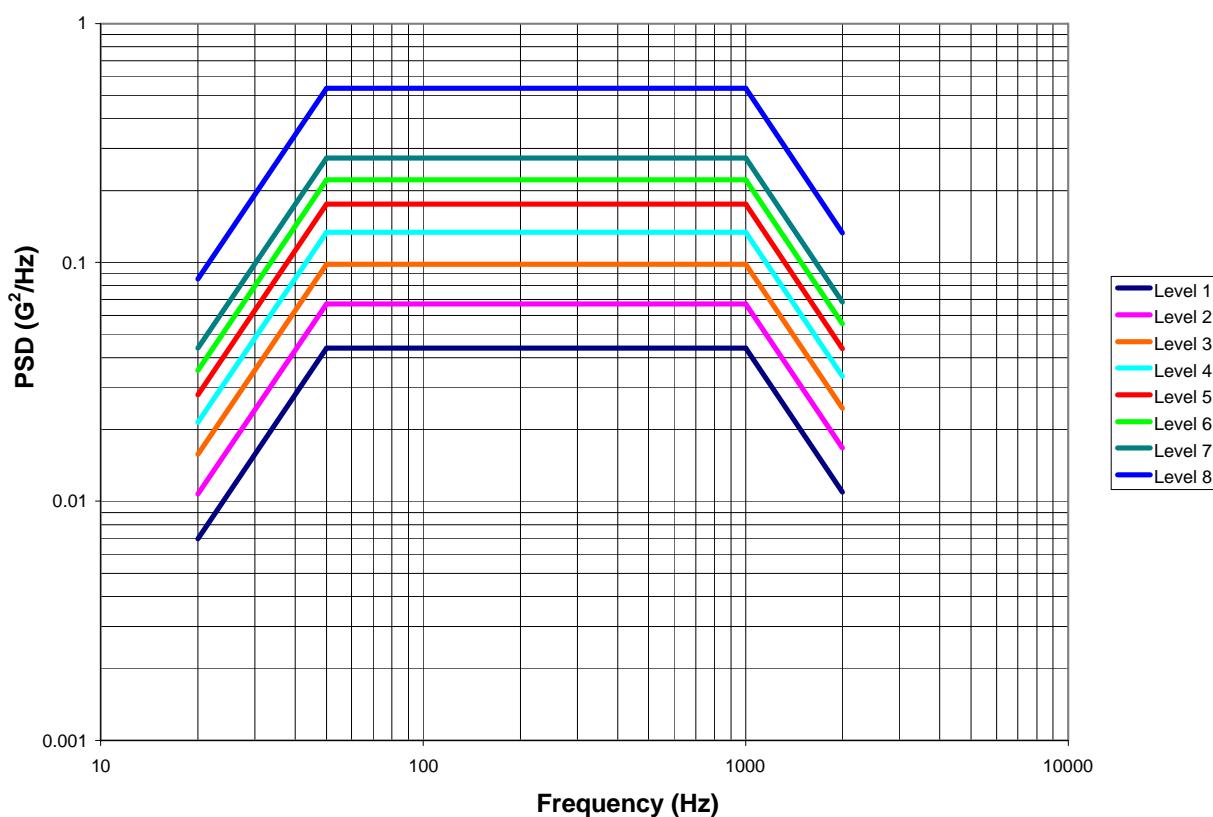
**Figure 1 Vibration Spectrum**

Table 1 Vibration Profile

Level 1	Level 2	Level 3
20 Hz @ 0.00698 G ² /Hz	20 Hz @ 0.0107 G ² /Hz	20 Hz @ 0.0157 G ² /Hz
20 - 50 Hz @ +6.0 dB/octave	20 - 50 Hz @ +6.0 dB/octave	20 - 50 Hz @ +6.0 dB/octave
50 - 1000 Hz @ 0.0438 G ² /Hz	50 - 1000 Hz @ 0.067 G ² /Hz	50 - 1000 Hz @ 0.0984 G ² /Hz
1000 - 2000 Hz @ -6.0 dB/octave	1000 - 2000 Hz @ -6.0 dB/octave	1000 - 2000 Hz @ -6.0 dB/octave
2000 Hz @ 0.0109 G ² /Hz	2000 Hz @ 0.0167 G ² /Hz	2000 Hz @ 0.0245 G ² /Hz
Composite = 8.0 G_{rms}	Composite = 9.9 G_{rms}	Composite = 12.0 G_{rms}

Level 4	Level 5	Level 6
20 Hz @ 0.0214 G ² /Hz	20 Hz @ 0.0279 G ² /Hz	20 Hz @ 0.0354 G ² /Hz
20 - 50 Hz @ +6.0 dB/octave	20 - 50 Hz @ +6.0 dB/octave	20 - 50 Hz @ +6.0 dB/octave
50 - 1000 Hz @ 0.134 G ² /Hz	50 - 1000 Hz @ 0.175 G ² /Hz	50 - 1000 Hz @ 0.2215 G ² /Hz
1000 - 2000 Hz @ -6.0 dB/octave	1000 - 2000 Hz @ -6.0 dB/octave	1000 - 2000 Hz @ -6.0 dB/octave
2000 Hz @ 0.0334 G ² /Hz	2000 Hz @ 0.0436 G ² /Hz	2000 Hz @ 0.0552 G ² /Hz
Composite = 14.0 G_{rms}	Composite = 16.0 G_{rms}	Composite = 18.0 G_{rms}

Level 7	Level 8
20 Hz @ 0.0437 G ² /Hz	20 Hz @ 0.0855 G ² /Hz
20 - 50 Hz @ +6.0 dB/octave	20 - 50 Hz @ +6.0 dB/octave
50 - 1000 Hz @ 0.2734 G ² /Hz	50 - 1000 Hz @ 0.5360 G ² /Hz
1000 - 2000 Hz @ -6.0 dB/octave	1000 - 2000 Hz @ -6.0 dB/octave
2000 Hz @ 0.0682 G ² /Hz	2000 Hz @ 0.1330 G ² /Hz
Composite = 20.0 G_{rms}	Composite = 28.0 G_{rms}

6. RESULTS AND COMMENTS

6.1 Summary of Testing –

6.1.1 Component Percentage Failure by Force Level

Vibration Level	Components Failed	%	Total %
8	51	9.0	9.0
10	45	7.9	16.9
12	43	7.6	24.5
14	39	6.9	31.4
16	39	6.9	38.3
18	59	10.4	48.7
20	73	12.9	61.6
28	111	19.6	81.1

6.1.2 Component Detachments

Vibration Level	Card	Components
20	79	U16
28	61	U16, U29
	62	U12, U16
	64	U16
	65	U7, U12, U16, U29
	66	U12, U16, U29
	67	U7, U12, U16, U29, U34
	79	U29

6.1.3 Batch 1 Time to Failure

Site	SN 62			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	1	330	18
U10	CLCC-20	2	430	28
U11	PDIP-20	1	175	12
U12	TSOP-50 Sn	0	413	20
U13	CLCC-20	0	191	14
U14	CLCC-20	0	180	12
U15	QFN-20 Sn	1	84	10
U16	TSOP-50 SnBi	1	370	20
U17	CLCC-20	1	480	survive
U18	BGA-225	0	145	12
U19	CSP-100	0	288	16
U2	BGA-225	0	58	8
U20	TQFP-144	0	187	14
U21	BGA-225	0	103	10
U22	CLCC-20	2	480	survive
U23	PDIP-20	0	480	survive
U24	TSOP-50 SnBi	0	167	12
U25	TSOP-50 Sn	1	181	14
U26	TSOP-50SnBi	1	344	18
U27	QFN-20	2	480	survive
U28	QFN-20	1	425	28
U29	TSOP-50 Sn	2	429	28
U3	TQFP-144	0	94	10
U30	PDIP-20	0	367	20
U31	TQFP-144	1	351	18
U32	CSP-100	0	302	18
U33	CSP-100	0	343	18
U34	TQFP-144	2	386	20
U35	CSP-100	0	264	16
U36	CSP-100	0	435	28
U37	CSP-100	0	480	survive
U38	PDIP-20	0	443	28
U39	TSOP-50 Sn	1	436	28
U4	BGA-225	0	14	8
U40	TSOP-50 SnBi	2	275	16
U41	TQFP-144	1	461	28

Site	SN 62			
	Comp Type	Reworks	TTF (min)	G Level
U42	CSP-100	0	383	20
U43	BGA-225	0	66	10
U44	BGA-225	0	148	12
U45	CLCC-20	1	462	28
U46	CLCC-20	0	463	28
U47	QFN-20	1	412	20
U48	TQFP-144	0	447	28
U49	PDIP-20	1	17	8
U5	BGA-225	0	19	8
U50	CSP-100	0	336	18
U51	PDIP-20	1	424	28
U52	CLCC-20	1	316	18
U53	CLCC-20	0	480	survive
U54	QFN-20	1	480	survive
U55	BGA-225	0	158	12
U56	BGA-225	0	287	16
U57	TQFP-144	1	285	16
U58	TQFP-144	0	249	16
U59	PDIP-20	0	480	survive
U6	BGA-225	0	54	8
U60	CSP-100	0	480	survive
U61	TSOP-50 Sn	0	466	28
U62	TSOP-50 SnBi	0	480	survive
U63	CSP-100	0	480	survive
U7	TQFP-144	2	319	18
U8	PDIP-20	1	50	8
U9	CLCC-20	1	426	28

Site	SN 64			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	1	424	28
U10	CLCC-20	2	450	28
U11	PDIP-20	1	480	survive
U12	TSOP-50 Sn	0	391	20
U13	CLCC-20	0	187	14
U14	CLCC-20	0	191	14
U15	QFN-20 Sn	1	136	12
U16	TSOP-50 SnBi	1	391	20
U17	CLCC-20	1	480	survive
U18	BGA-225	0	63	10
U19	CSP-100	0	304	18
U2	BGA-225	0	21	8
U20	TQFP-144	0	215	14
U21	BGA-225	0	34	8
U22	CLCC-20	2	480	survive
U23	PDIP-20	0	480	survive
U24	TSOP-50 SnBi	0	266	16
U25	TSOP-50 Sn	1	178	12
U26	TSOP-50SnBi	1	369	20
U27	QFN-20	2	480	survive
U28	QFN-20	1	480	survive
U29	TSOP-50 Sn	2	440	28
U3	TQFP-144	0	141	12
U30	PDIP-20	1	92	10
U31	TQFP-144	1	449	28
U32	CSP-100	0	426	28
U33	CSP-100	0	291	16
U34	TQFP-144	2	372	20
U35	CSP-100	0	267	16
U36	CSP-100	0	480	survive
U37	CSP-100	0	480	survive
U38	PDIP-20	0	24	8
U39	TSOP-50 Sn	1	474	28
U4	BGA-225	0	14	8
U40	TSOP-50 SnBi	2	334	18
U41	TQFP-144	1	405	20
U42	CSP-100	0	455	28
U43	BGA-225	0	35	8
U44	BGA-225	0	64	10
U45	CLCC-20	1	480	survive
U46	CLCC-20	0	480	survive
U47	QFN-20	1	388	20
U48	TQFP-144	0	440	28
U49	PDIP-20	2	290	16

Site	SN 64			
	Comp Type	Reworks	TTF (min)	G Level
U5	BGA-225	0	13	8
U50	CSP-100	0	336	18
U51	PDIP-20	1	61	10
U52	CLCC-20	1	450	28
U53	CLCC-20	0	459	28
U54	QFN-20	1	480	survive
U55	BGA-225	0	218	14
U56	BGA-225	0	158	12
U57	TQFP-144	1	308	18
U58	TQFP-144	0	271	16
U59	PDIP-20	0	480	survive
U6	BGA-225	0	39	8
U60	CSP-100	0	480	survive
U61	TSOP-50 Sn	0	438	28
U62	TSOP-50 SnBi	0	475	28
U63	CSP-100	0	480	survive
U7	TQFP-144	2	363	20
U8	PDIP-20	2	480	survive
U9	CLCC-20	1	466	28

Site	SN 68			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	1	373	20
U10	CLCC-20	2	471	28
U11	PDIP-20	1	480	survive
U12	TSOP-50 Sn	0	388	20
U13	CLCC-20	0	157	12
U14	CLCC-20	0	178	12
U15	QFN-20 Sn	1	113	10
U16	TSOP-50 SnBi	1	414	20
U17	CLCC-20	1	480	survive
U18	BGA-225	0	131	12
U19	CSP-100	0	374	20
U2	BGA-225	0	62	10
U20	TQFP-144	0	201	14
U21	BGA-225	0	46	8
U22	CLCC-20	2	480	survive
U23	PDIP-20	0	480	survive
U24	TSOP-50 SnBi	0	255	16
U25	TSOP-50 Sn	1	152	12
U26	TSOP-50SnBi	1	292	16
U27	QFN-20	2	480	survive
U28	QFN-20	1	421	28
U29	TSOP-50 Sn	2	449	28
U3	TQFP-144	0	101	10
U30	PDIP-20	1	69	10
U31	TQFP-144	1	452	28
U32	CSP-100	0	375	20
U33	CSP-100	0	324	18
U34	TQFP-144	2	378	20
U35	CSP-100	0	214	14
U36	CSP-100	0	332	18
U37	CSP-100	0	480	survive
U38	PDIP-20	0	82	10
U39	TSOP-50 Sn	1	456	28
U4	BGA-225	0	12	8
U40	TSOP-50 SnBi	2	379	20
U41	TQFP-144	1	408	20
U42	CSP-100	0	424	28
U43	BGA-225	0	29	8
U44	BGA-225	0	70	10
U45	CLCC-20	1	480	survive
U46	CLCC-20	0	461	28
U47	QFN-20	1	347	18
U48	TQFP-144	0	438	28
U49	PDIP-20	2	38	8

Site	SN 68			
	Comp Type	Reworks	TTF (min)	G Level
	U5 BGA-225	0	14	8
U50	CSP-100	0	252	16
U51	PDIP-20	1	184	14
U52	CLCC-20	1	422	28
U53	CLCC-20	0	462	28
U54	QFN-20	1	480	survive
U55	BGA-225	0	185	14
U56	BGA-225	0	175	12
U57	TQFP-144	1	309	18
U58	TQFP-144	0	215	14
U59	PDIP-20	0	480	survive
U6	BGA-225	0	30	8
U60	CSP-100	0	480	survive
U61	TSOP-50 Sn	0	434	28
U62	TSOP-50 SnBi	0	480	survive
U63	CSP-100	0	480	survive
U7	TQFP-144	2	381	20
U8	PDIP-20	2	480	survive
U9	CLCC-20	1	426	28

Site	SN 79			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	1	378	20
U10	CLCC-20	2	287	16
U11	PDIP-20	1	480	survive
U12	TSOP-50 Sn	0	423	28
U13	CLCC-20	0	128	12
U14	CLCC-20	0	124	12
U15	QFN-20 Sn	1	64	10
U16	TSOP-50 SnBi	1	345	18
U17	CLCC-20	1	480	survive
U18	BGA-225	0	106	10
U19	CSP-100	0	310	18
U2	BGA-225	0	65	10
U20	TQFP-144	0	144	12
U21	BGA-225	0	62	10
U22	CLCC-20	2	434	28
U23	PDIP-20	0	480	survive
U24	TSOP-50 SnBi	0	240	14
U25	TSOP-50 Sn	1	155	12
U26	TSOP-50SnBi	1	438	28
U27	QFN-20	2	480	survive
U28	QFN-20	1	434	28
U29	TSOP-50 Sn	2	409	20
U3	TQFP-144	0	113	10
U30	PDIP-20	1	250	16
U31	TQFP-144	1	442	28
U32	CSP-100	0	334	18
U33	CSP-100	0	337	18
U34	TQFP-144	2	367	20
U35	CSP-100	0	311	18
U36	CSP-100	0	480	survive
U37	CSP-100	0	480	survive
U38	PDIP-20	0	480	survive
U39	TSOP-50 Sn	1	428	28
U4	BGA-225	0	15	8
U40	TSOP-50 SnBi	2	327	18
U41	TQFP-144	1	480	survive
U42	CSP-100	0	398	20
U43	BGA-225	0	22	8
U44	BGA-225	0	44	8
U45	CLCC-20	1	416	20
U46	CLCC-20	0	412	20
U47	QFN-20	1	407	20
U48	TQFP-144	0	439	28
U49	PDIP-20	2	31	8

Site	SN 79			
	Comp Type	Reworks	TTF (min)	G Level
U5	BGA-225	0	15	8
U50	CSP-100	0	307	18
U51	PDIP-20	1	403	20
U52	CLCC-20	1	447	28
U53	CLCC-20	0	473	28
U54	QFN-20	1	480	survive
U55	BGA-225	0	116	10
U56	BGA-225	0	143	12
U57	TQFP-144	1	343	18
U58	TQFP-144	0	130	12
U59	PDIP-20	0	480	survive
U6	BGA-225	0	40	8
U60	CSP-100	0	480	survive
U61	TSOP-50 Sn	0	460	28
U62	TSOP-50 SnBi	0	468	28
U63	CSP-100	0	480	survive
U7	TQFP-144	2	267	16
U8	PDIP-20	2	480	survive
U9	CLCC-20	1	406	20

6.1.4 Batch 2 Time to Failure

Site	SN 61			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	2	385	20
U10	CLCC-20	1	431	28
U11	PDIP-20	2	480	Survive
U12	TSOP-50 Sn	0	396	20
U13	CLCC-20	0	185	14
U14	CLCC-20	0	201	14
U15	QFN-20 Sn	2	132	12
U16	TSOP-50 SnBi	2	361	20
U17	CLCC-20	2	404	20
U18	BGA-225	0	89	10
U19	CSP-100	0	341	18
U2	BGA-225	0	30	8
U20	TQFP-144	0	246	16
U21	BGA-225	0	168	12
U22	CLCC-20	1	458	28
U23	PDIP-20	1	480	Survive
U24	TSOP-50 SnBi	0	205	14
U25	TSOP-50 Sn	2	192	14
U26	TSOP-50SnBi	0	430	28
U27	QFN-20	1	480	Survive
U28	QFN-20	2	450	28
U29	TSOP-50 Sn	1	424	28
U3	TQFP-144	0	106	10
U30	PDIP-20	0	437	28
U31	TQFP-144	2	422	28
U32	CSP-100	0	345	18
U33	CSP-100	0	378	20
U34	TQFP-144	1	370	20
U35	CSP-100	0	298	16
U36	CSP-100	0	402	20
U37	CSP-100	0	480	Survive
U38	PDIP-20	1	458	28
U39	TSOP-50 Sn	0	431	28
U4	BGA-225	0	12	8
U40	TSOP-50 SnBi	1	365	20
U41	TQFP-144	0	430	28
U42	CSP-100	0	379	20
U43	BGA-225	0	72	10
U44	BGA-225	0	268	16
U45	CLCC-20	0	480	Survive
U46	CLCC-20	1	354	18

	U47	QFN-20	X1 STENCIL	424	28
Site	SN 61				
	Comp Type	Reworks	TTF (min)	G Level	
U48	TQFP-144	1	390	20	
U49	PDIP-20	1	9	8	
U5	BGA-225	0	12	8	
U50	CSP-100	0	293	16	
U51	PDIP-20	2	453	28	
U52	CLCC-20	0	480	Survive	
U53	CLCC-20	1	480	Survive	
U54	QFN-20	1	460	28	
U55	BGA-225	0	195	14	
U56	BGA-225	0	227	14	
U57	TQFP-144	0	313	18	
U58	TQFP-144	1	263	16	
U59	PDIP-20	1	480	Survive	
U6	BGA-225	0	82	10	
U60	CSP-100	0	480	Survive	
U61	TSOP-50 Sn	1	414	20	
U62	TSOP-50 SnBi	1	454	28	
U63	CSP-100	0	480	Survive	
U7	TQFP-144	1	293	16	
U8	PDIP-20	1	480	Survive	
U9	CLCC-20	2	422	28	

Site	SN 63			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	2	388	20
U10	CLCC-20	1	431	28
U11	PDIP-20	2	480	Survive
U12	TSOP-50 Sn	0	408	20
U13	CLCC-20	0	214	14
U14	CLCC-20	0	238	14
U15	QFN-20 Sn	2	122	12
U16	TSOP-50 SnBi	2	434	28
U17	CLCC-20	2	480	Survive
U18	BGA-225	0	231	14
U19	CSP-100	0	378	20
U2	BGA-225	0	74	10
U20	TQFP-144	0	121	12
U21	BGA-225	0	107	10
U22	CLCC-20	1	434	28
U23	PDIP-20	1	480	Survive
U24	TSOP-50 SnBi	0	279	16
U25	TSOP-50 Sn	2	142	12
U26	TSOP-50SnBi	0	379	20
U27	QFN-20	1	480	Survive
U28	QFN-20	2	428	28
U29	TSOP-50 Sn	1	480	Survive
U3	TQFP-144	0	133	12
U30	PDIP-20	0	16	8
U31	TQFP-144	2	433	28
U32	CSP-100	0	332	18
U33	CSP-100	0	308	18
U34	TQFP-144	1	121	12
U35	CSP-100	0	278	16
U36	CSP-100	0	480	Survive
U37	CSP-100	0	480	Survive
U38	PDIP-20	1	480	Survive
U39	TSOP-50 Sn	0	475	28
U4	BGA-225	0	384	20
U40	TSOP-50 SnBi	1	394	20
U41	TQFP-144	0	449	28
U42	CSP-100	0	422	28
U43	BGA-225	0	12	8
U44	BGA-225	0	121	12
U45	CLCC-20	0	480	Survive
U46	CLCC-20	1	480	Survive
U47	QFN-20	X1 STENCIL	374	20
U48	TQFP-144	1	431	28
U49	PDIP-20	1	41	8

Site	SN 63			
	Comp Type	Reworks	TTF (min)	G Level
U5	BGA-225	0	480	8
U50	CSP-100	0	279	16
U51	PDIP-20	2	246	16
U52	CLCC-20	0	421	28
U53	CLCC-20	1	422	28
U54	QFN-20	1	424	28
U55	BGA-225	0	200	14
U56	BGA-225	0	266	16
U57	TQFP-144	0	121	12
U58	TQFP-144	1	280	16
U59	PDIP-20	1	480	Survive
U6	BGA-225	0	72	10
U60	CSP-100	0	480	Survive
U61	TSOP-50 Sn	1	421	28
U62	TSOP-50 SnBi	1	422	28
U63	CSP-100	0	480	Survive
U7	TQFP-144	1	361	20
U8	PDIP-20	1	33	8
U9	CLCC-20	2	480	Survive

Site	SN 65			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	2	281	16
U10	CLCC-20	1	424	28
U11	PDIP-20	2	480	Survive
U12	TSOP-50 Sn	0	334	18
U13	CLCC-20	0	160	12
U14	CLCC-20	0	98	10
U15	QFN-20 Sn	2	24	8
U16	TSOP-50 SnBi	2	378	20
U17	CLCC-20	2	480	Survive
U18	BGA-225	0	108	10
U19	CSP-100	0	333	18
U2	BGA-225	0	48	8
U20	TQFP-144	0	62	10
U21	BGA-225	0	37	8
U22	CLCC-20	1	434	28
U23	PDIP-20	1	480	Survive
U24	TSOP-50 SnBi	0	231	14
U25	TSOP-50 Sn	2	155	12
U26	TSOP-50SnBi	0	335	18
U27	QFN-20	1	471	28
U28	QFN-20	2	368	20
U29	TSOP-50 Sn	1	327	18
U3	TQFP-144	0	101	10
U30	PDIP-20	0	30	8
U31	TQFP-144	2	432	28
U32	CSP-100	0	322	18
U33	CSP-100	0	310	18
U34	TQFP-144	1	63	10
U35	CSP-100	0	195	14
U36	CSP-100	0	311	18
U37	CSP-100	0	480	Survive
U38	PDIP-20	1	480	Survive
U39	TSOP-50 Sn	0	472	28
U4	BGA-225	0	3	8
U40	TSOP-50 SnBi	1	383	20
U41	TQFP-144	0	332	18
U42	CSP-100	0	430	28
U43	BGA-225	0	14	8
U44	BGA-225	0	63	10
U45	CLCC-20	0	472	28
U46	CLCC-20	1	455	28
U47	QFN-20	X1 STENCIL	480	Survive
U48	TQFP-144	1	181	14
U49	PDIP-20	1	174	12

Site	SN 65			
	Comp Type	Reworks	TTF (min)	G Level
	U5	BGA-225	0	6
U50	CSP-100	0	323	18
U51	PDIP-20	2	480	Survive
U52	CLCC-20	0	121	12
U53	CLCC-20	1	480	Survive
U54	QFN-20	1	115	10
U55	BGA-225	0	127	12
U56	BGA-225	0	180	12
U57	TQFP-144	0	341	18
U58	TQFP-144	1	260	16
U59	PDIP-20	1	480	Survive
U6	BGA-225	0	28	8
U60	CSP-100	0	480	Survive
U61	TSOP-50 Sn	1	121	12
U62	TSOP-50 SnBi	1	115	10
U63	CSP-100	0	480	Survive
U7	TQFP-144	1	241	16
U8	PDIP-20	1	480	Survive
U9	CLCC-20	2	337	18

Site	SN 66			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	1	381	20
U10	CLCC-20	2	425	28
U11	PDIP-20	1	480	Survive
U12	TSOP-50 Sn	0	345	18
U13	CLCC-20	0	222	14
U14	CLCC-20	0	241	16
U15	QFN-20 Sn	1	188	14
U16	TSOP-50 SnBi	1	407	20
U17	CLCC-20	1	480	Survive
U18	BGA-225	0	149	12
U19	CSP-100	0	329	18
U2	BGA-225	0	130	12
U20	TQFP-144	0	181	14
U21	BGA-225	0	86	10
U22	CLCC-20	2	443	28
U23	PDIP-20	0	480	Survive
U24	TSOP-50 SnBi	0	236	14
U25	TSOP-50 Sn	1	181	14
U26	TSOP-50SnBi	1	357	18
U27	QFN-20	2	480	Survive
U28	QFN-20	1	480	Survive
U29	TSOP-50 Sn	2	412	20
U3	TQFP-144	0	127	12
U30	PDIP-20	1	222	14
U31	TQFP-144	1	415	20
U32	CSP-100	0	341	18
U33	CSP-100	0	358	18
U34	TQFP-144	2	393	20
U35	CSP-100	0	359	18
U36	CSP-100	0	368	20
U37	CSP-100	0	480	Survive
U38	PDIP-20	0	61	10
U39	TSOP-50 Sn	1	398	20
U4	BGA-225	0	8	8
U40	TSOP-50 SnBi	2	270	16
U41	TQFP-144	1	444	28
U42	CSP-100	0	369	20
U43	BGA-225	0	34	8
U44	BGA-225	0	183	14
U45	CLCC-20	1	446	28
U46	CLCC-20	0	438	28
U47	QFN-20	1	389	20
U48	TQFP-144	0	433	28
U49	PDIP-20	2	63	10

Site	SN 66			
	Comp Type	Reworks	TTF (min)	G Level
U5	BGA-225	0	11	5
U50	CSP-100	0	309	18
U51	PDIP-20	1	468	28
U52	CLCC-20	1	472	28
U53	CLCC-20	0	449	28
U54	QFN-20	X1 STENCIL	480	Survive
U55	BGA-225	0	280	16
U56	BGA-225	0	249	16
U57	TQFP-144	1	303	18
U58	TQFP-144	0	233	14
U59	PDIP-20	0	480	Survive
U6	BGA-225	0	32	8
U60	CSP-100	0	480	Survive
U61	TSOP-50 Sn	0	429	28
U62	TSOP-50 SnBi	0	454	28
U63	CSP-100	0	480	Survive
U7	TQFP-144	2	320	18
U8	PDIP-20	2	480	Survive
U9	CLCC-20	1	413	20

Site	SN 67			
	Comp Type	Reworks	TTF (min)	G Level
U1	TQFP-144	2	244	16
U10	CLCC-20	1	341	18
U11	PDIP-20	2	480	Survive
U12	TSOP-50 Sn	0	181	14
U13	CLCC-20	0	138	12
U14	CLCC-20	0	103	10
U15	QFN-20 Sn	2	83	10
U16	TSOP-50 SnBi	2	366	20
U17	CLCC-20	2	480	Survive
U18	BGA-225	0	97	10
U19	CSP-100	0	284	16
U2	BGA-225	0	34	8
U20	TQFP-144	0	148	12
U21	BGA-225	0	37	8
U22	CLCC-20	1	356	18
U23	PDIP-20	1	480	Survive
U24	TSOP-50 SnBi	0	202	14
U25	TSOP-50 Sn	2	89	10
U26	TSOP-50SnBi	0	304	18
U27	QFN-20	1	480	Survive
U28	QFN-20	2	436	28
U29	TSOP-50 Sn	1	346	18
U3	TQFP-144	0	78	10
U30	PDIP-20	0	115	10
U31	TQFP-144	2	375	20
U32	CSP-100	0	306	18
U33	CSP-100	0	317	18
U34	TQFP-144	1	299	16
U35	CSP-100	0	238	14
U36	CSP-100	0	244	16
U37	CSP-100	0	480	Survive
U38	PDIP-20	1	428	28
U39	TSOP-50 Sn	0	451	28
U4	BGA-225	0	4	8
U40	TSOP-50 SnBi	1	382	20
U41	TQFP-144	0	358	18
U42	CSP-100	0	370	20
U43	BGA-225	0	13	8
U44	BGA-225	0	82	10
U45	CLCC-20	0	427	28
U46	CLCC-20	1	433	28
U47	QFN-20	X1 STENCIL	398	20
U48	TQFP-144	1	373	20

Site	SN 67			
	Comp Type	Reworks	TTF (min)	G Level
	U49 PDIP-20	1	480	Survive
U5 BGA-225	0	4	8	
U50 CSP-100	0	309	18	
U51 PDIP-20	1	480	Survive	
U52 CLCC-20	0	421	28	
U53 CLCC-20	1	443	28	
U54 QFN-20	1	465	28	
U55 BGA-225	0	77	10	
U56 BGA-225	0	185	14	
U57 TQFP-144	0	308	18	
U58 TQFP-144	1	200	14	
U59 PDIP-20	1	480	Survive	
U6 BGA-225	0	29	8	
U60 CSP-100	0	480	Survive	
U61 TSOP-50 Sn	1	337	18	
U62 TSOP-50 SnBi	1	414	20	
U63 CSP-100	0	480	Survive	
U7 TQFP-144	1	135	12	
U8 PDIP-20	1	480	Survive	
U9 CLCC-20	2	340	18	

6.2 Resistance Data: Individual Component Observations

Event Detector

Each of the 63 components was individually monitored using an Event Detector. Testing was conducted in two batches, 4 and 5 boards, with a total of 256 or 320 channels, respectively. Settings on the Event Detector were set to record data in 1 minute cycles, recording 30 times per cycle. Thus, the Event Detectors polled for events every 2 seconds. The Event Detector was set to a 300 ohm threshold. The maximum occurrence limit was not selected. An image of the resistance wiring can be seen in the figure below.



Resistance Measurement Procedure

The boards were inserted into the supplied vibration fixture and connected to the event detector. A half-inch braided strap was connected to the fixture, event detector and strain monitoring system ground connections. The vibration levels were conducted and the accelerometer and event detector systems began taking readings for the one hour duration. The event measurements were re-started for each test level.

SITE	SN 79	SN 64	SN 68	SN 62
U1	X	X	X	X
U10	X	X	X	X
U11				X
U12	X	X	X	X
U13	X	X	X	X
U14	X	X	X	X
U15	X	X	X	X
U16	X	X	X	X
U17				
U18	X	X	X	X
U19	X	X	X	X
U2	X	X	X	X
U20	X	X	X	X
U21	X	X	X	X
U22	X			
U23				
U24	X	X	X	X
U25	X	X	X	X
U26	X	X	X	X
U27				
U28	X		X	X
U29	X	X	X	X
U3	X	X	X	X
U30	X	X	X	X
U31	X	X	X	X
U32	X	X	X	X
U33	X	X	X	X
U34	X	X	X	X
U35	X	X	X	X
U36			X	X
U37				
U38		X	X	X
U39	X	X	X	X
U4	X	X	X	X
U40	X	X	X	X
U41		X	X	X
U42	X	X	X	X
U43	X	X	X	X
U44	X	X	X	X
U45	X			X
U46	X		X	X
U47	X	X	X	X
U48	X	X	X	X
U49	X	X	X	X
U5	X	X	X	X
U50	X	X	X	X
U51	X	X	X	X
U52	X	X	X	X

SITE	SN 79	SN 64	SN 68	SN 62
U53	X	X	X	
U54				
U55	X	X	X	X
U56	X	X	X	X
U57	X	X	X	X
U58	X	X	X	X
U59				
U6	X	X	X	X
U60				
U61	X	X	X	X
U62	X	X		
U63				
U7	X	X	X	X
U8				X
U9	X	X	X	X

Table 2 : Batch 1: Verified Module/Board Failures End of Test

SITE	SN 61	SN 63	SN 65	SN 66	SN 67
U1	X	X	X	X	X
U10	X		X	X	X
U11					
U12	X	X	X	X	X
U13	X	X	X	X	X
U14	X	X	X	X	X
U15	X	X	X	X	X
U16	X	X	X	X	X
U17	X				
U18	X	X	X	X	X
U19	X	X	X	X	X
U2	X	X	X	X	X
U20	X	X	X	X	X
U21	X	X	X	X	X
U22	X	X	X	X	X
U23					
U24	X	X	X	X	X
U25	X	X	X	X	X
U26	X	X	X	X	X
U27					
U28	X	X	X		X (int)
U29	X	7ohms	X	X	X
U3	X	X	X	X	X
U30	X	X	X	X	X
U31	X	X	X	X	X
U32	X	X	X	X	X
U33	X	X	X	X	X
U34	X	X	X	X	X
U35	X	X	X	X	X
U36	X		X	X	X
U37					
U38	X			X	X
U39	X	X	X	X	X
U4	X	X	X	X	X
U40	X	X	X	X	X
U41	X	X	X	X	X
U42	X	X	X	X	X
U43	X	X	X	X	X
U44	X	X	X	X	X
U45			X	X	X
U46	X		X	X	X
U47	X	X		X	X
U48	X	X	X	X	X
U49	X	X	X	X	X
U5	X	X	X	X	X
U50	X	X	X	X	X
U51	X	X		X	
SITE	SN 61	SN 63	SN 65	SN 66	SN 67

U52		X	X	X	X
U53		X		X	X
U54	X	X	X		X
U55	X	X	X	X	X
U56	X	X	X	X	X
U57	X	X	X	X	X
U58	X	X	X	X	X
U59					
U6	X	X	X	X	X
U60					
U61	X	X	X	X	X
U62	X	X	X	X	X
U63					
U7	X	X	X	X	X
U8		X			
U9	X		X	X	X

Table 3 : Batch 2: Verified Module/Board Failures End of Test

**First Vibration Level Failed**

7. CONTRACTUAL STATEMENTS

Deviation from the documented procedure? (Yes/No) No

If Yes, state deviation:

Has any tests or documentation related to this report been subcontracted? No

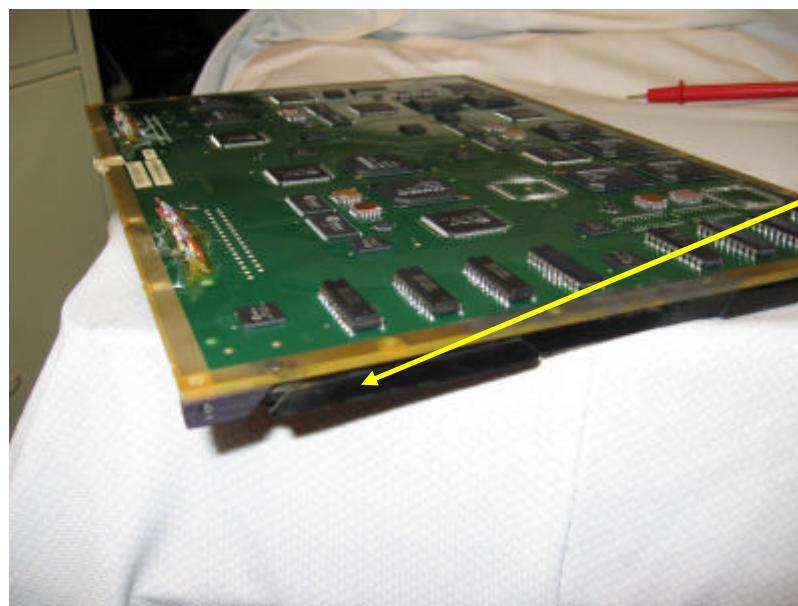
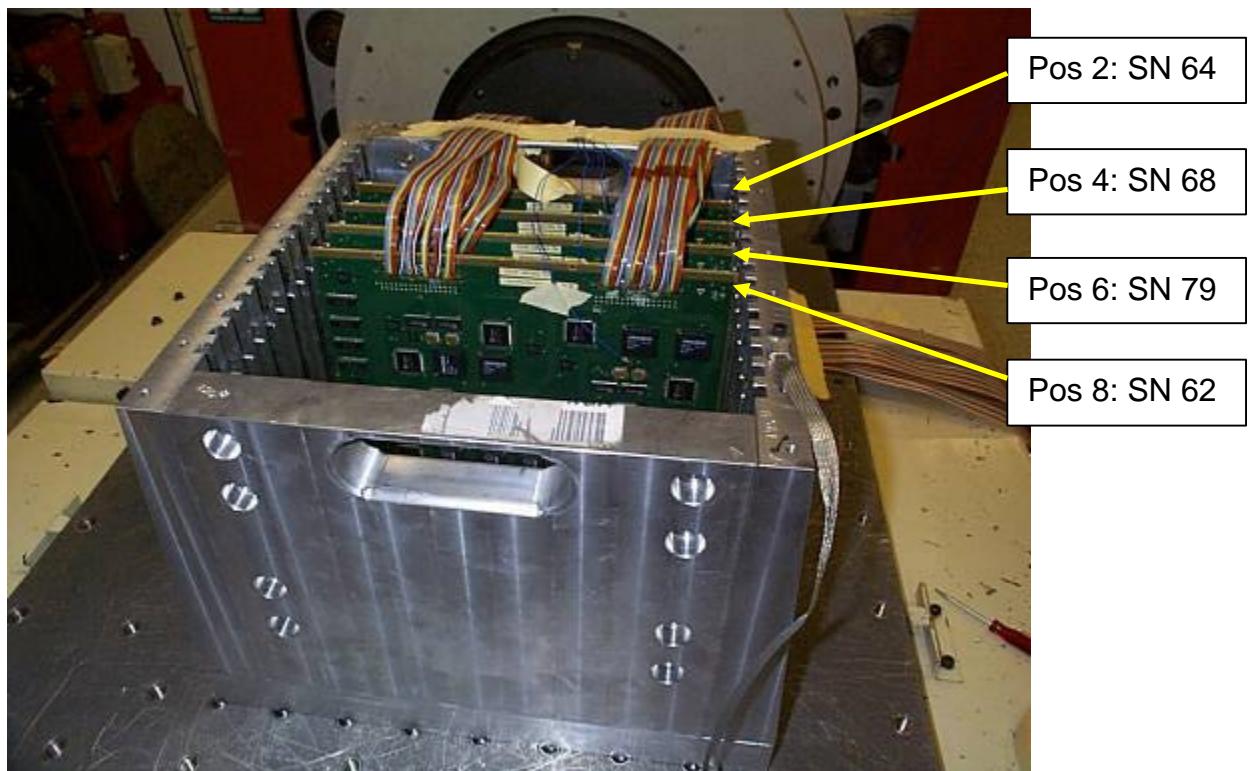
If Yes, state work subcontracted:

Results in the report relate only to the item tested.

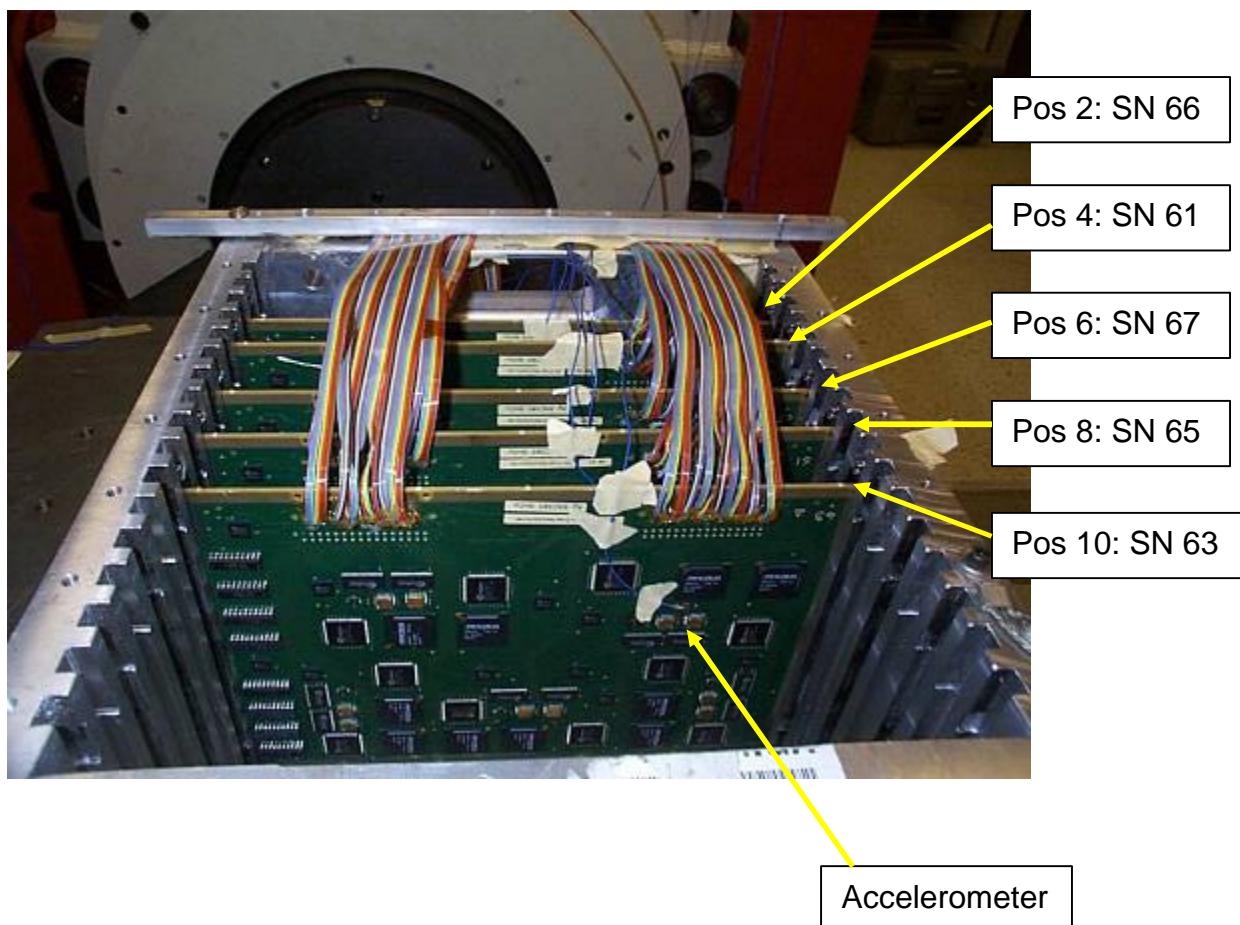
Tests and measurements stated in this report are performed within the precision of the Standards and Equipment listed.

8. APPENDIX A: Test Setup Photos

8.1 Batch 1 Test Setup

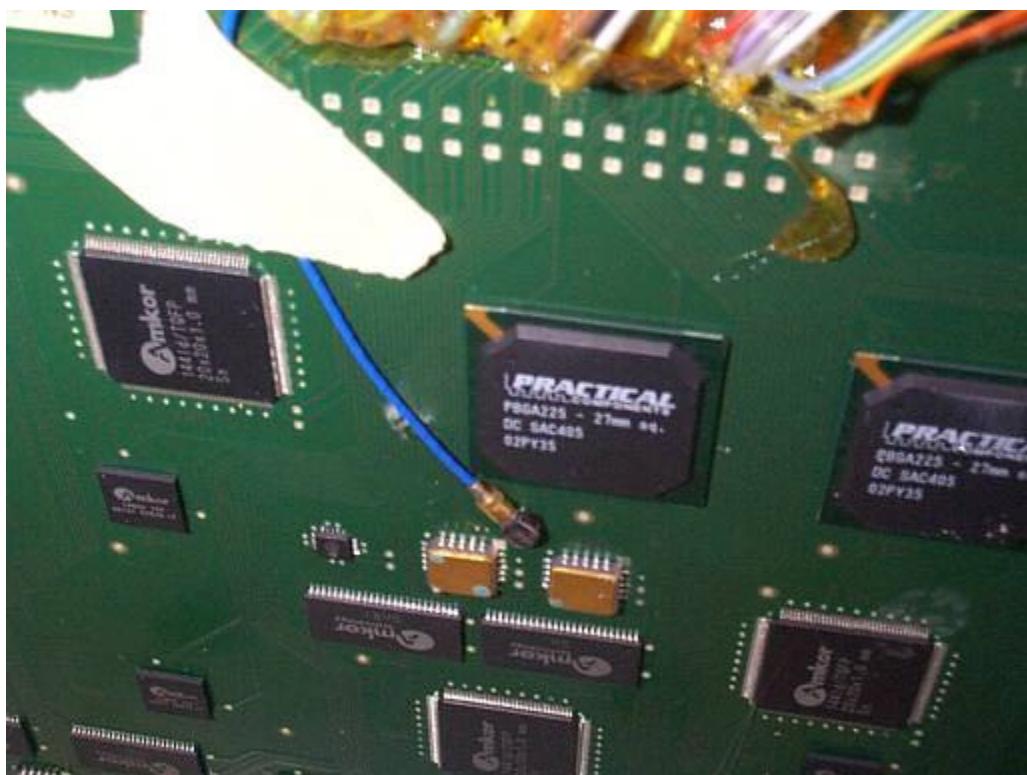


8.2 Batch 2 Test Setup



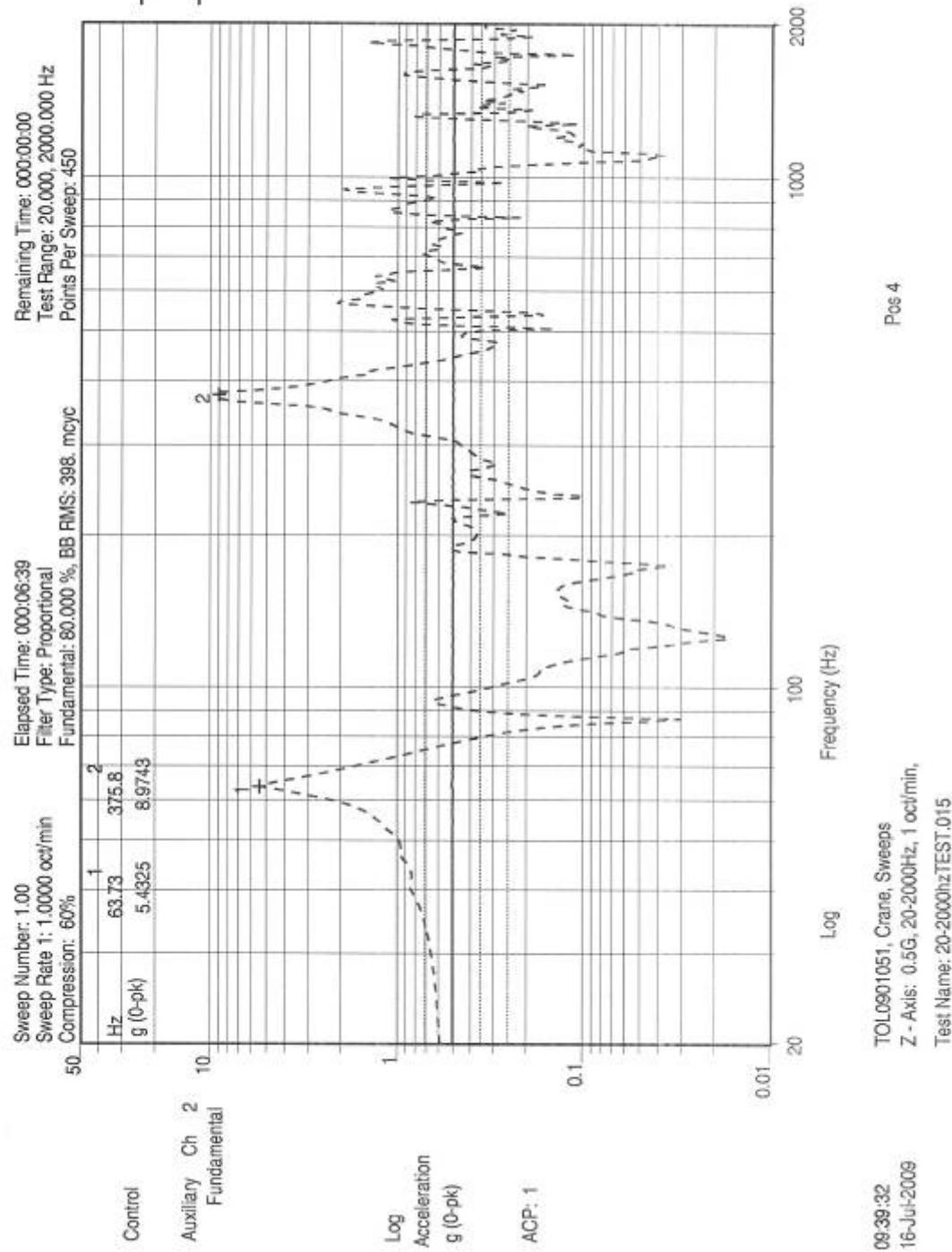
Position	Resonance 1 (64Hz)		Resonance 2 (376 Hz)	
	G (pk)	Disp “ (p-p)	G (pk)	Disp “ (p-p)
2	5	0.0239	9	0.0012
4	5	0.0239	8	0.0011
6	9	0.0430	8	0.0011
8	6	0.0287	12	0.0017
10	10	0.0478	19	0.0026

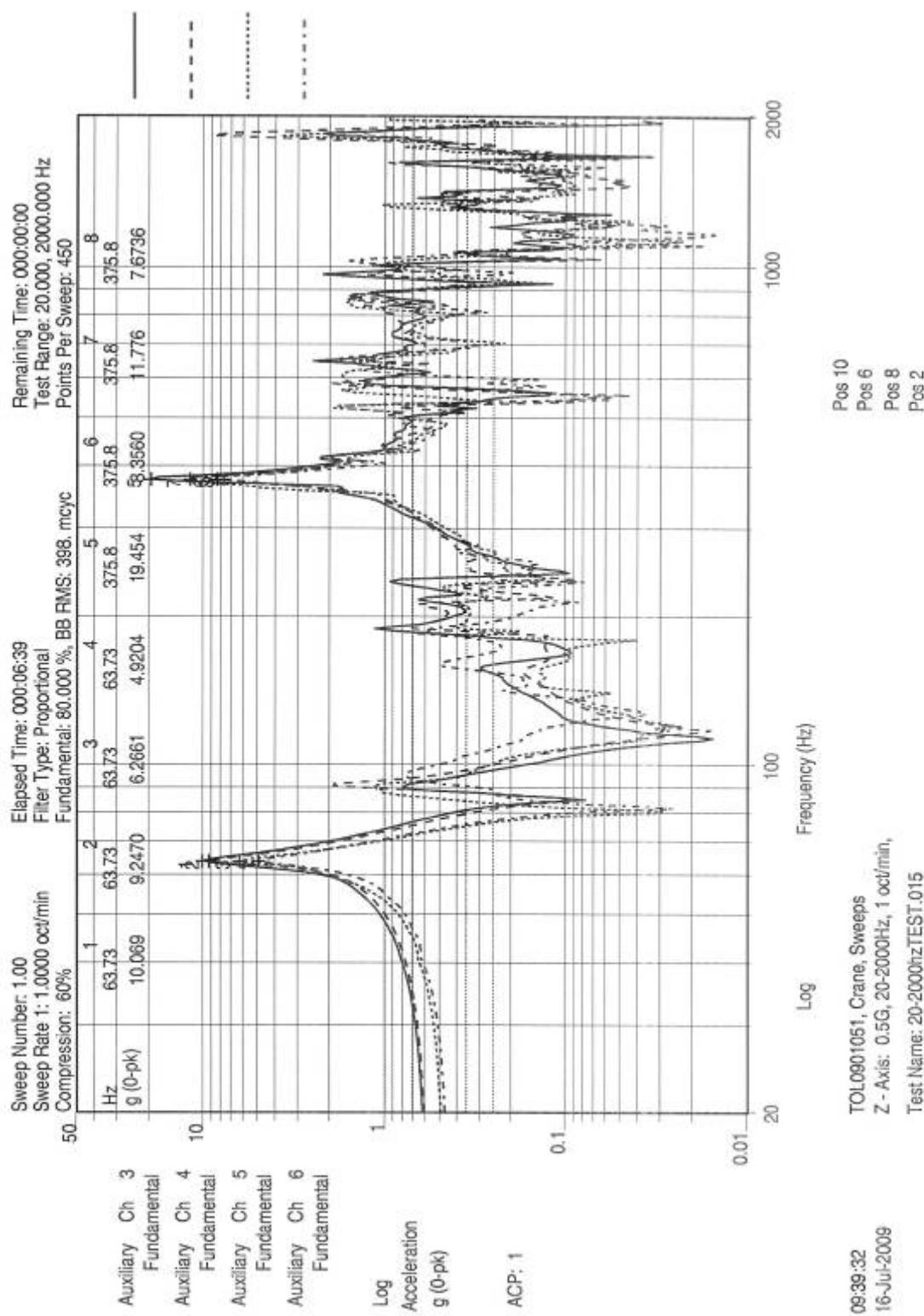
8.3 Detail Accelerometer Location



9. APPENDIX B: Plots

9.1 Sine Sweeps:





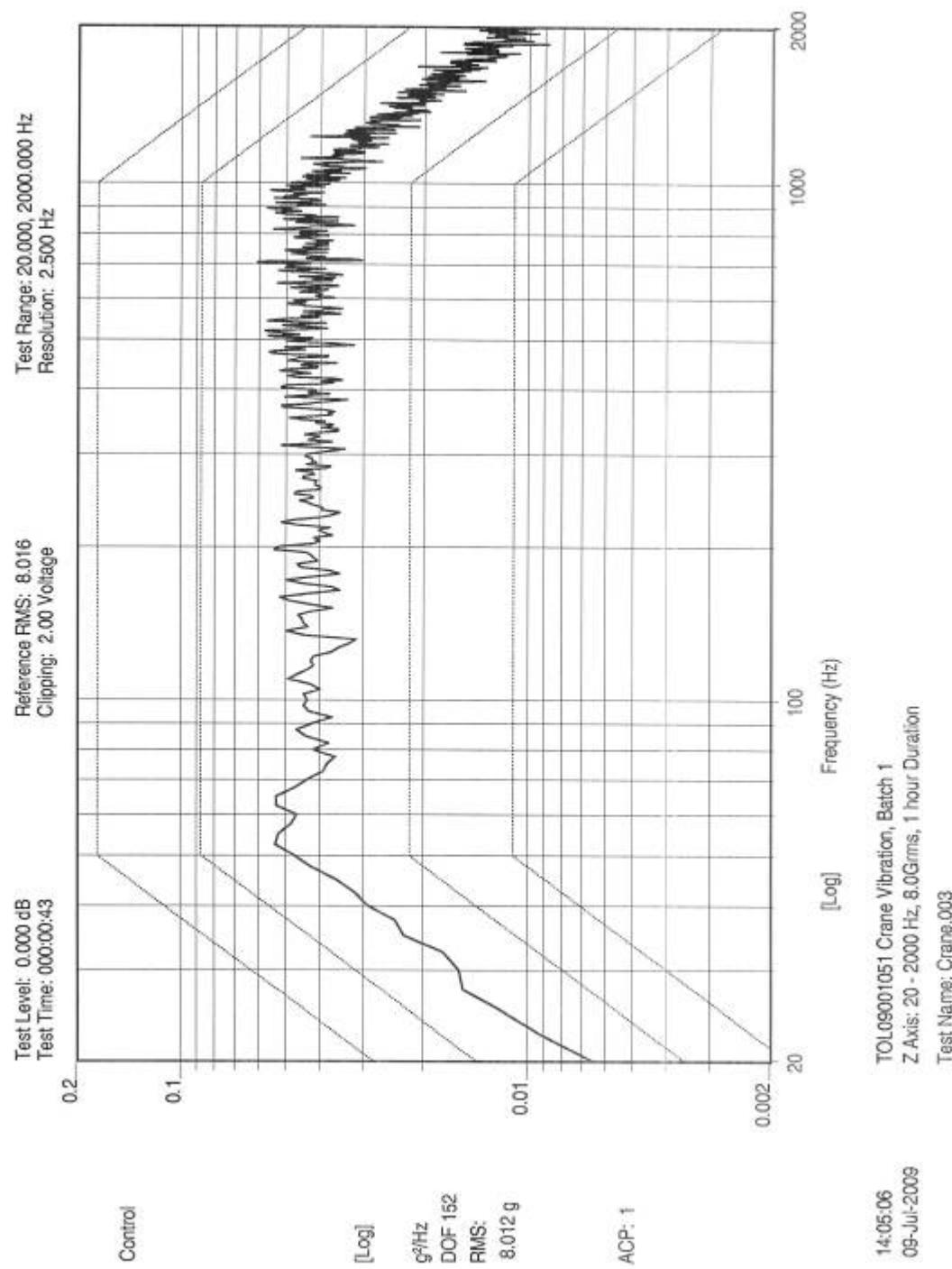
9.2 Random Response Summary Batch 1:

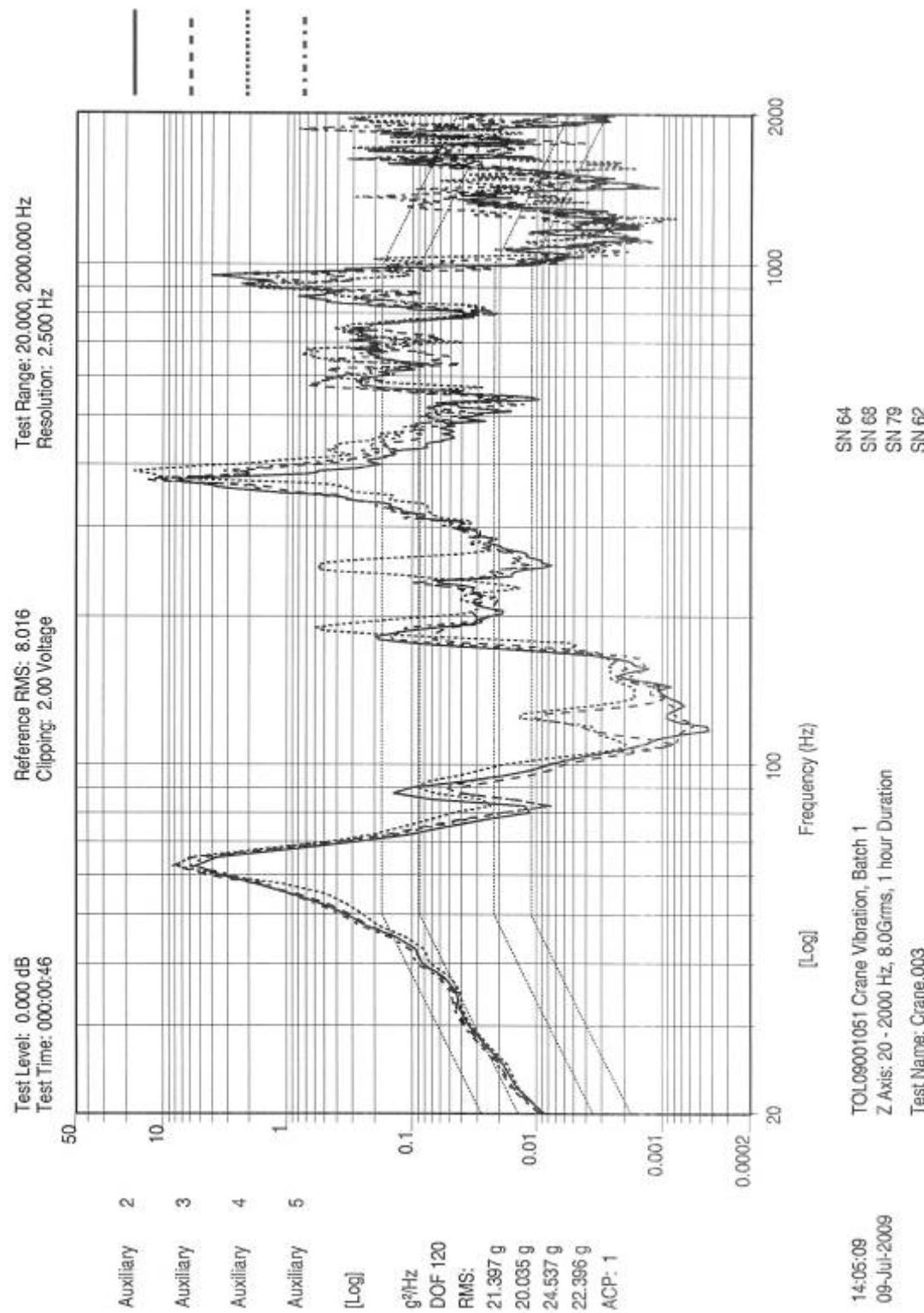
Input Level (G rms)	Response Level (G rms)			
	SN 64	SN 68	SN 79	SN 62
8	20	20.6	26.6	24
10	23.3	25	30	29
12	29	29	32	34.5
14	37.9	40	40	43.3
16	43.6	46.8	46.8	47.6
18	46.4	53.1	51	51
20	52.8	55.5	58.2	56.1
28	70.4	67.9	67	69.1

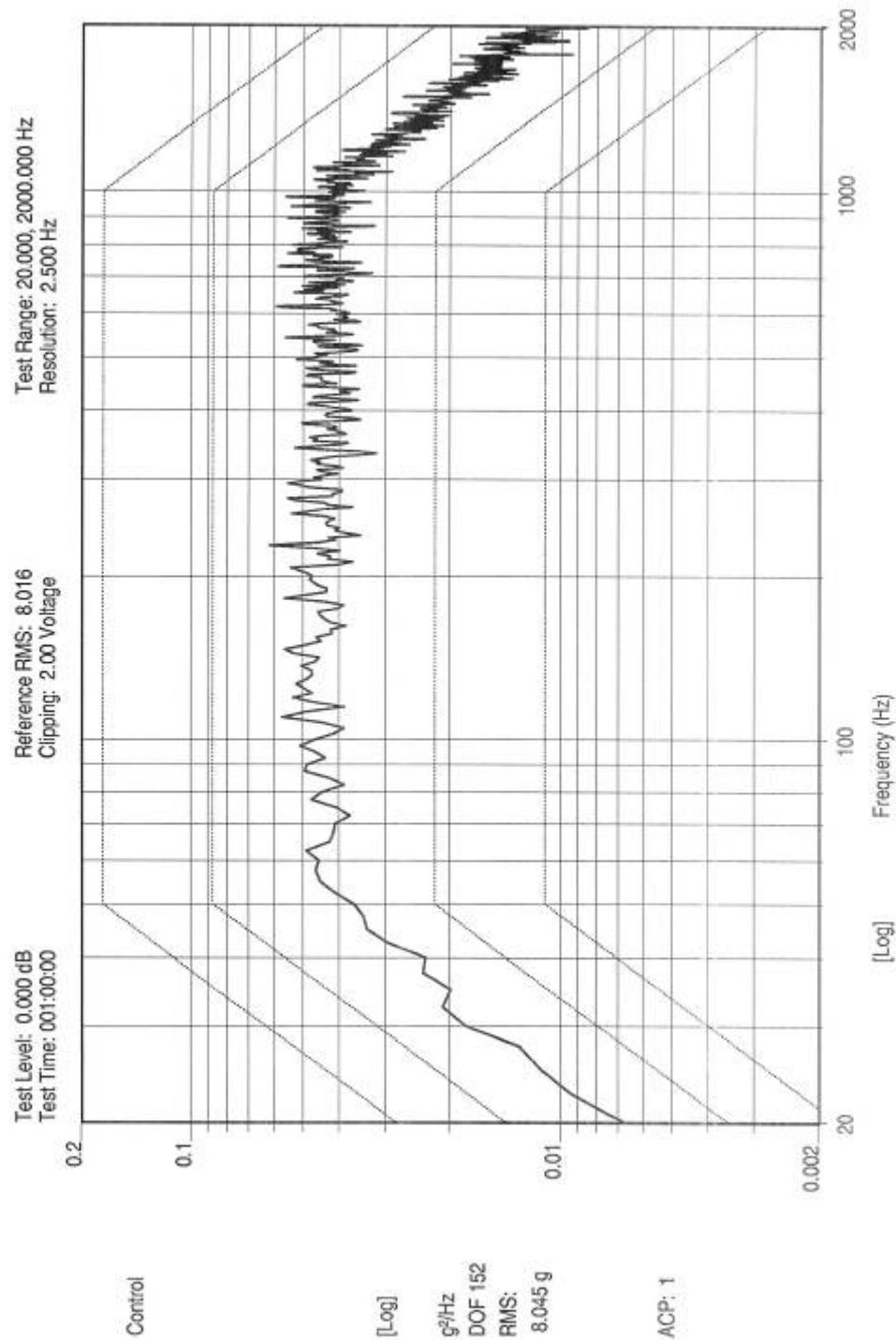
9.3 Random Response Summary Batch 2:

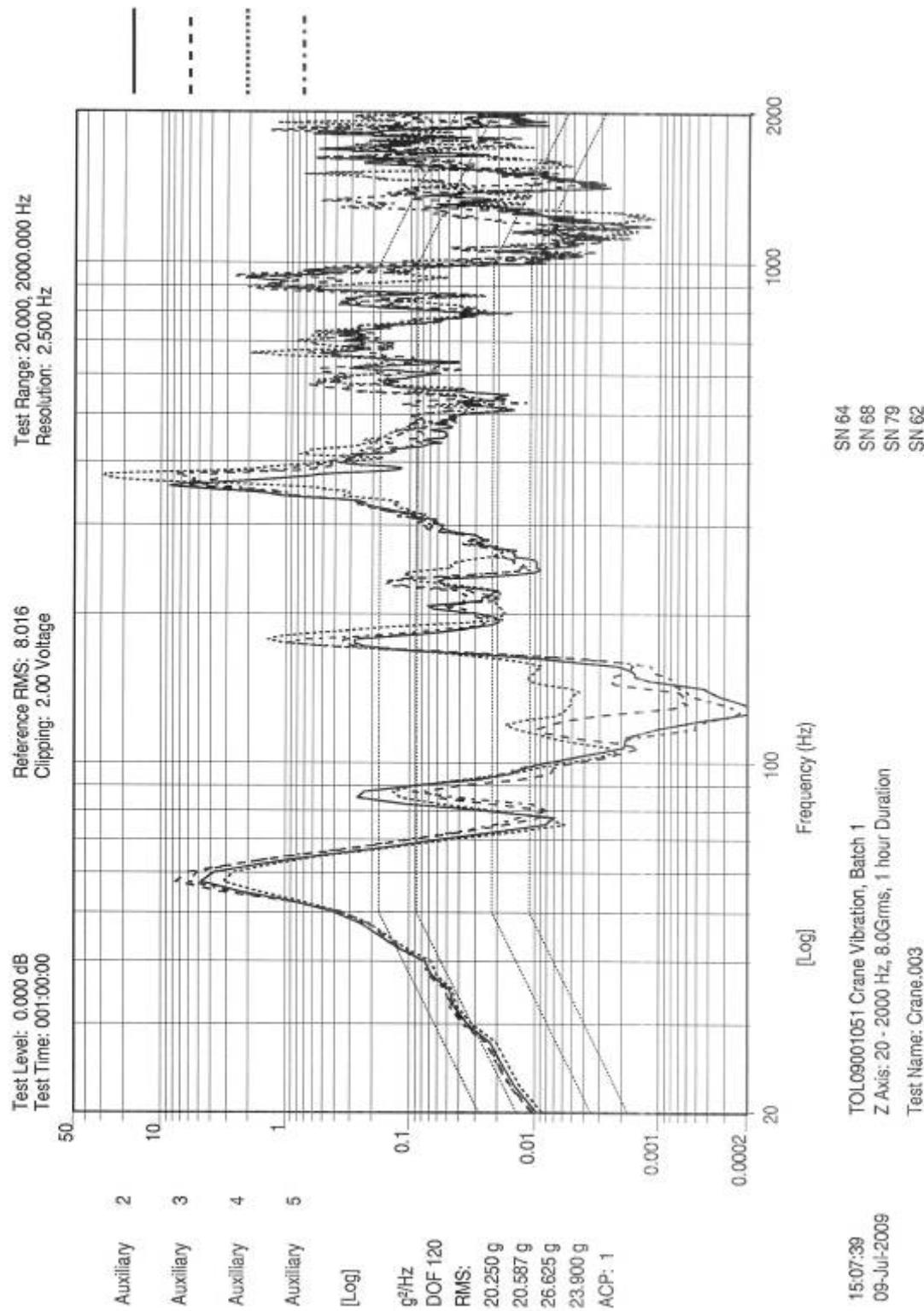
Input Level (G rms)	Response Level (G rms)				
	SN 63	SN 67	SN 65	SN 66	SN 61
8	19.7	23.7	25.3	19.7	15
10	24.3	27	30.8	26.1	20.7
12	29.7	33.6	34.7	30.8	27.5
14	34.7	37.7	38	35	31
16	42.4	Accel dtched	43.4	40.1	32.1
18	45.6	46.3	45.5	42.9	35
20	44.2	47	47.7	46.2	37.8
28	64.8	65.5	70.8	67	54.8

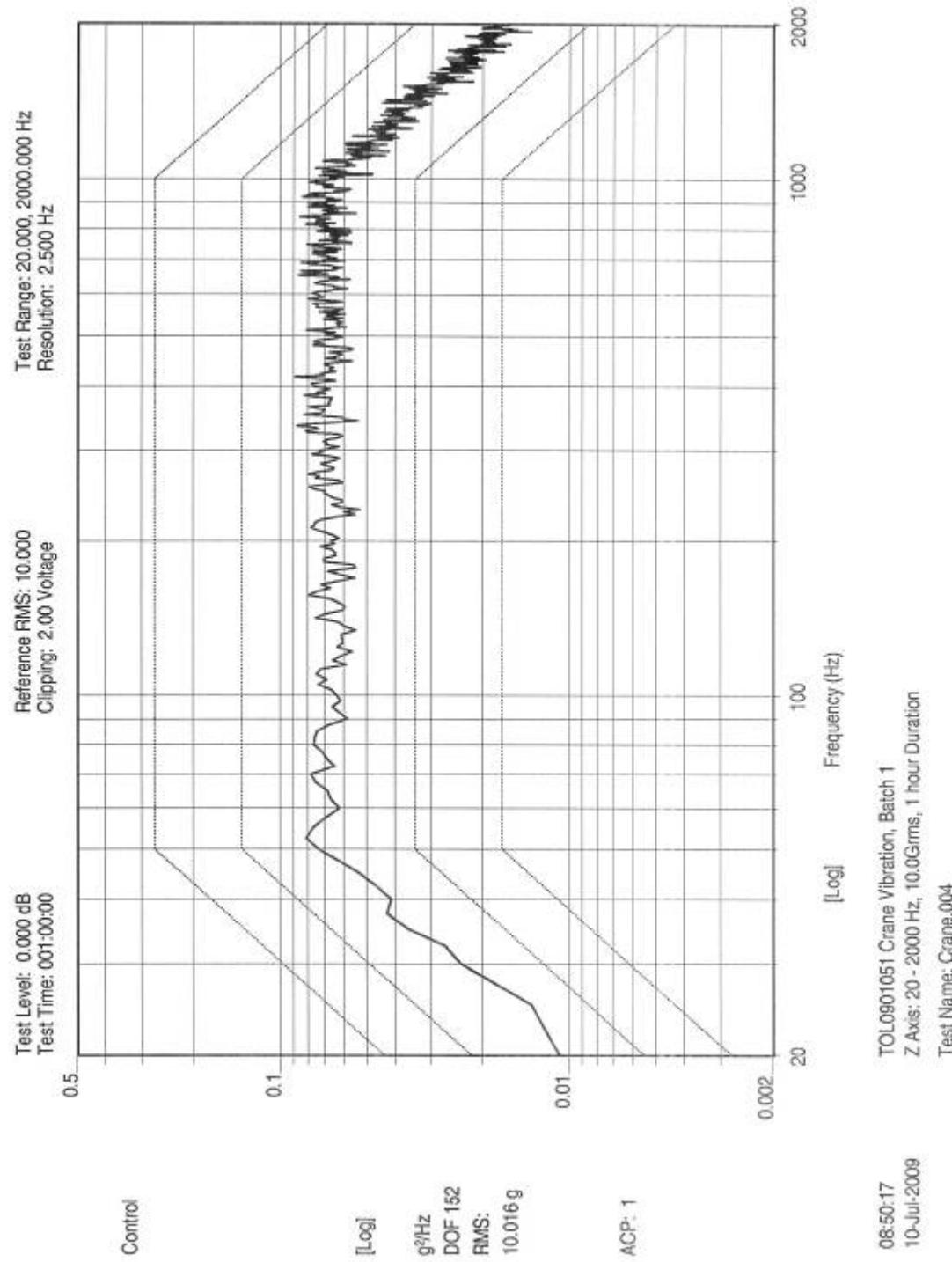
9.4 Random Response Plots Batch 1:

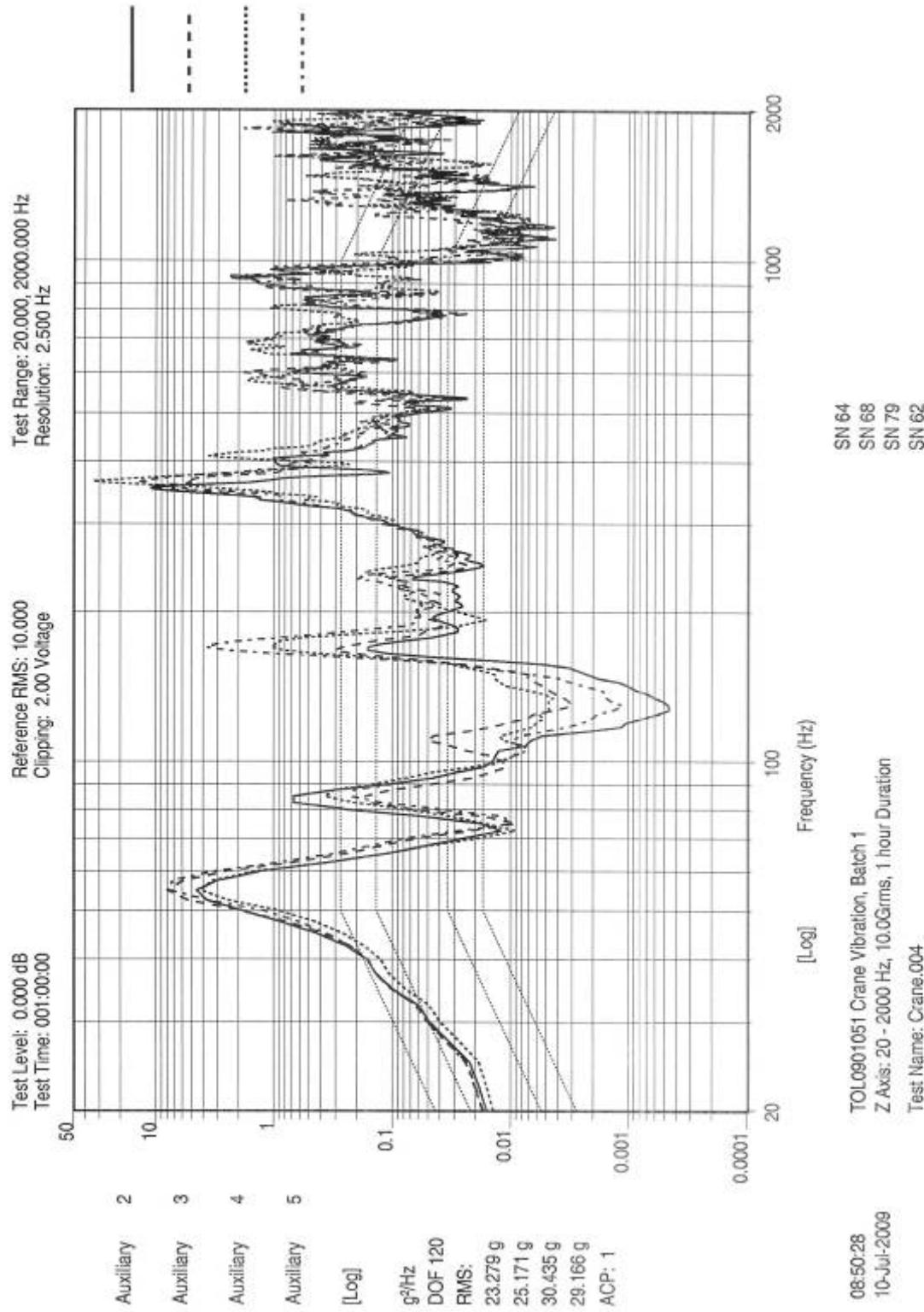


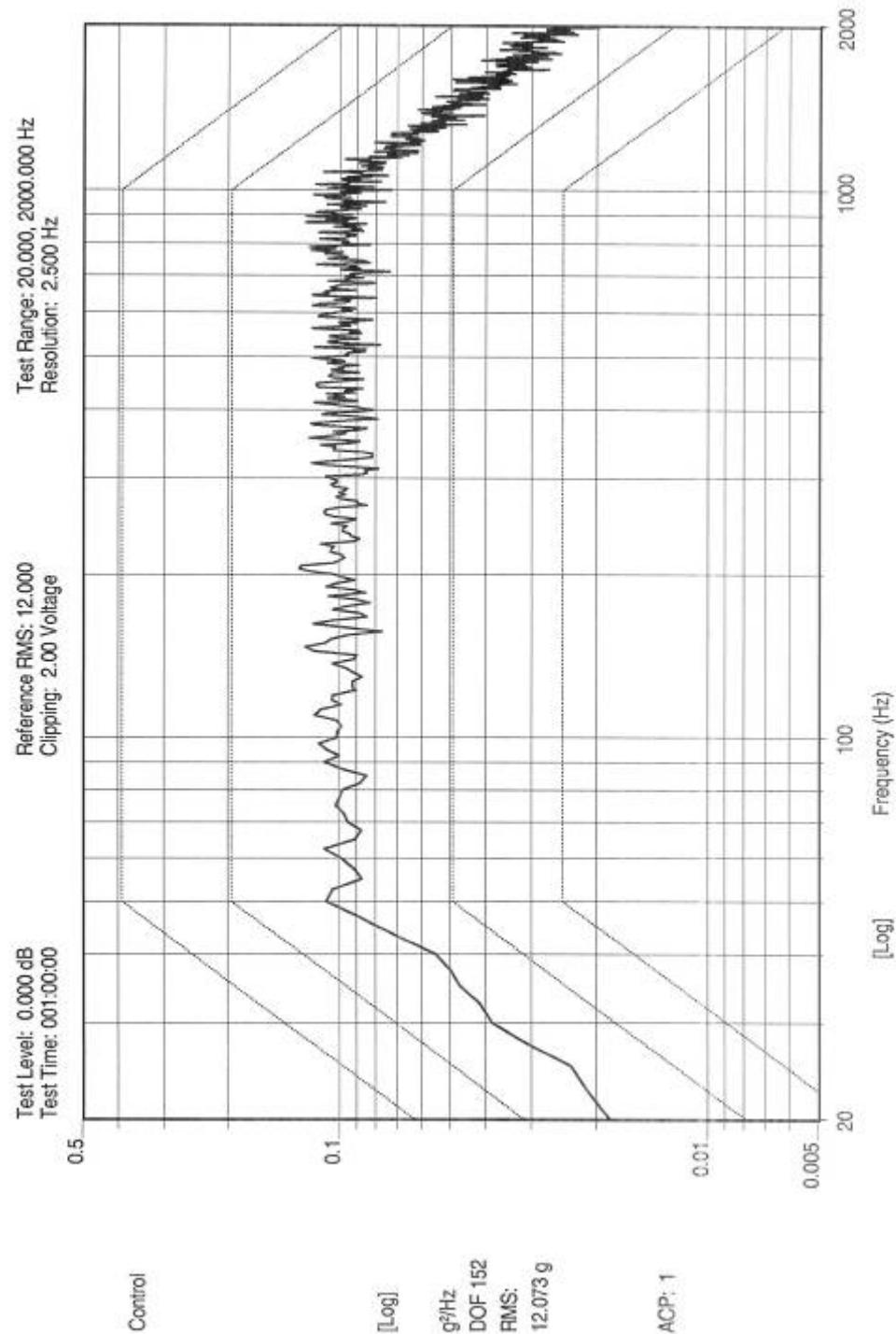


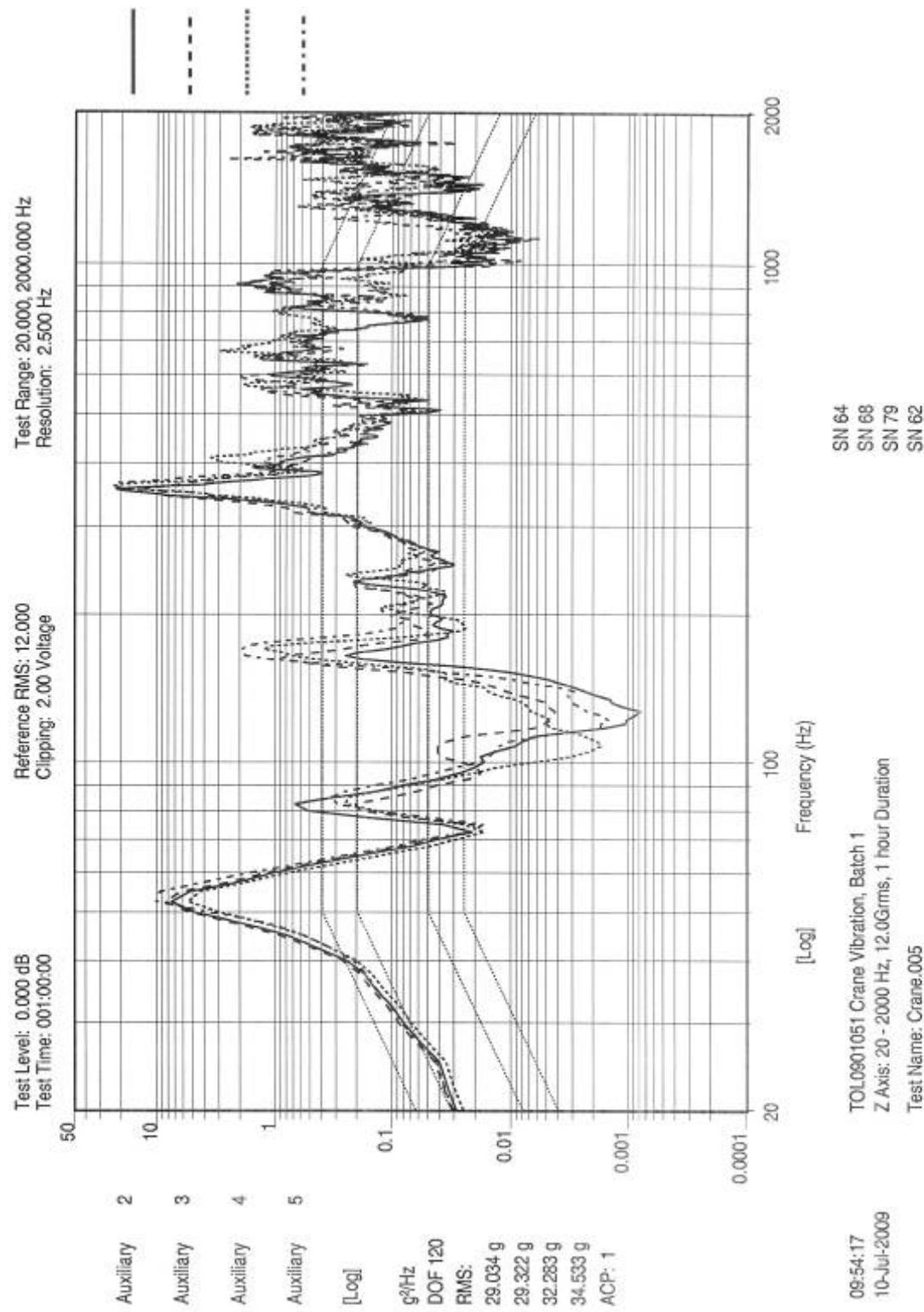


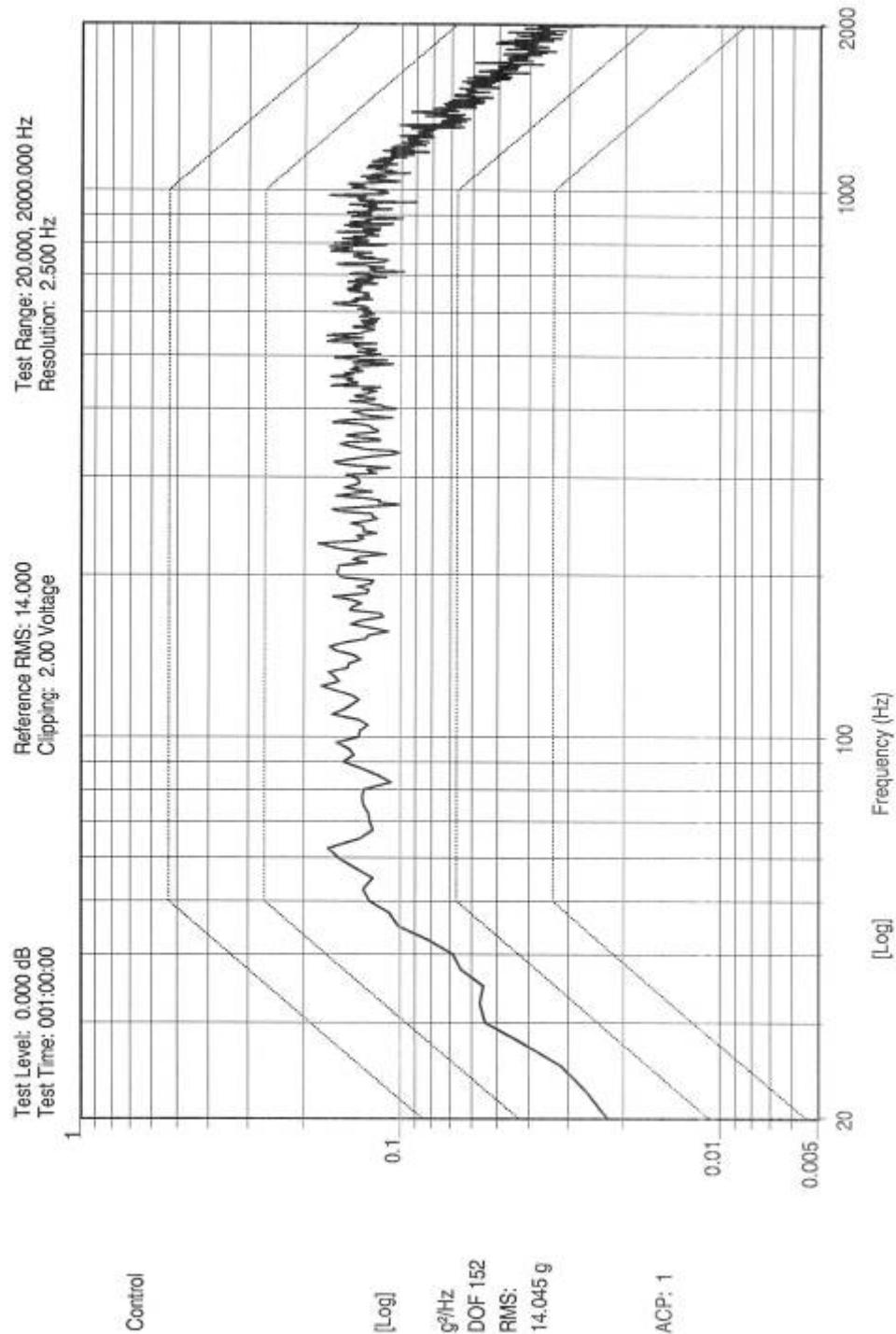






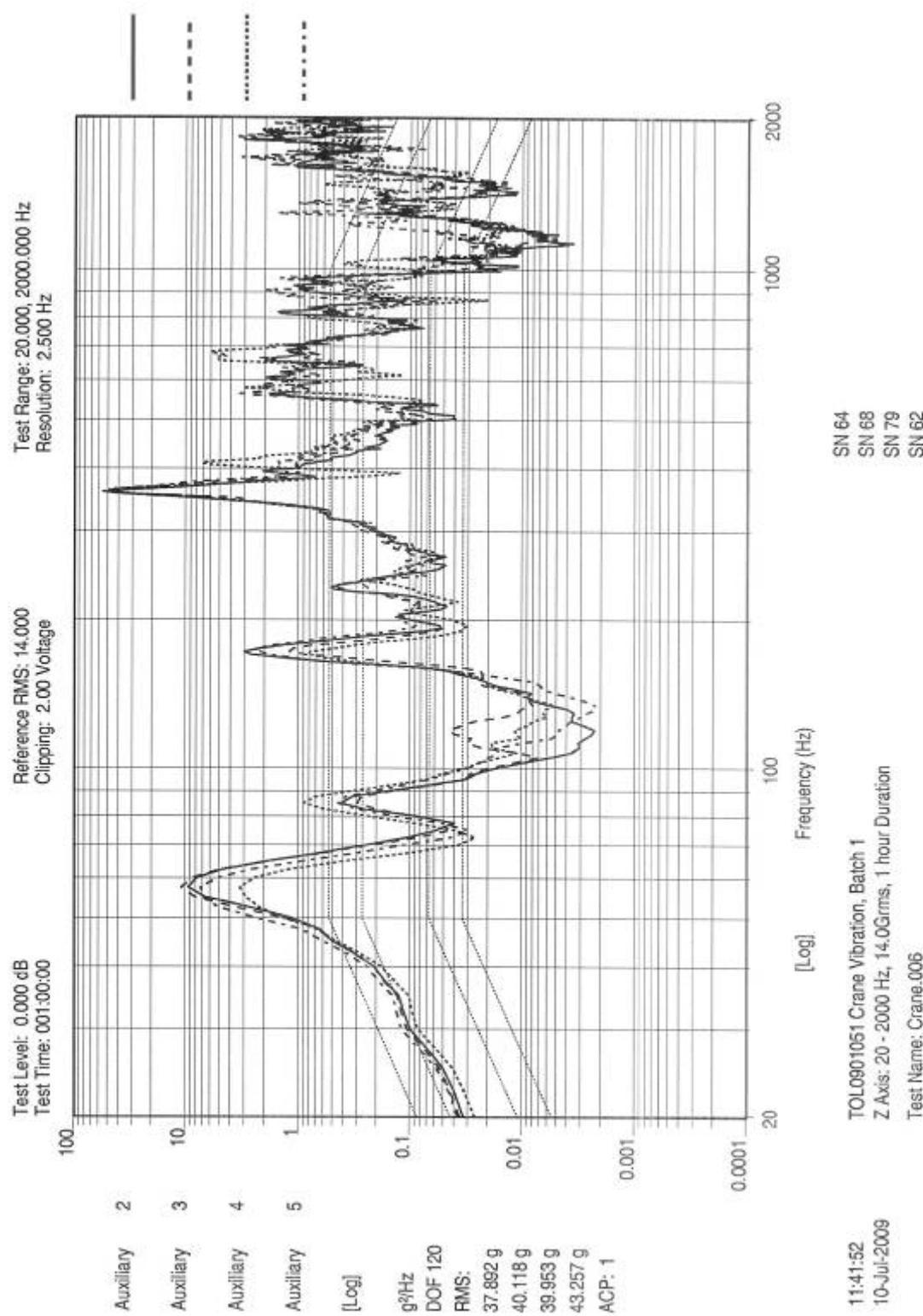


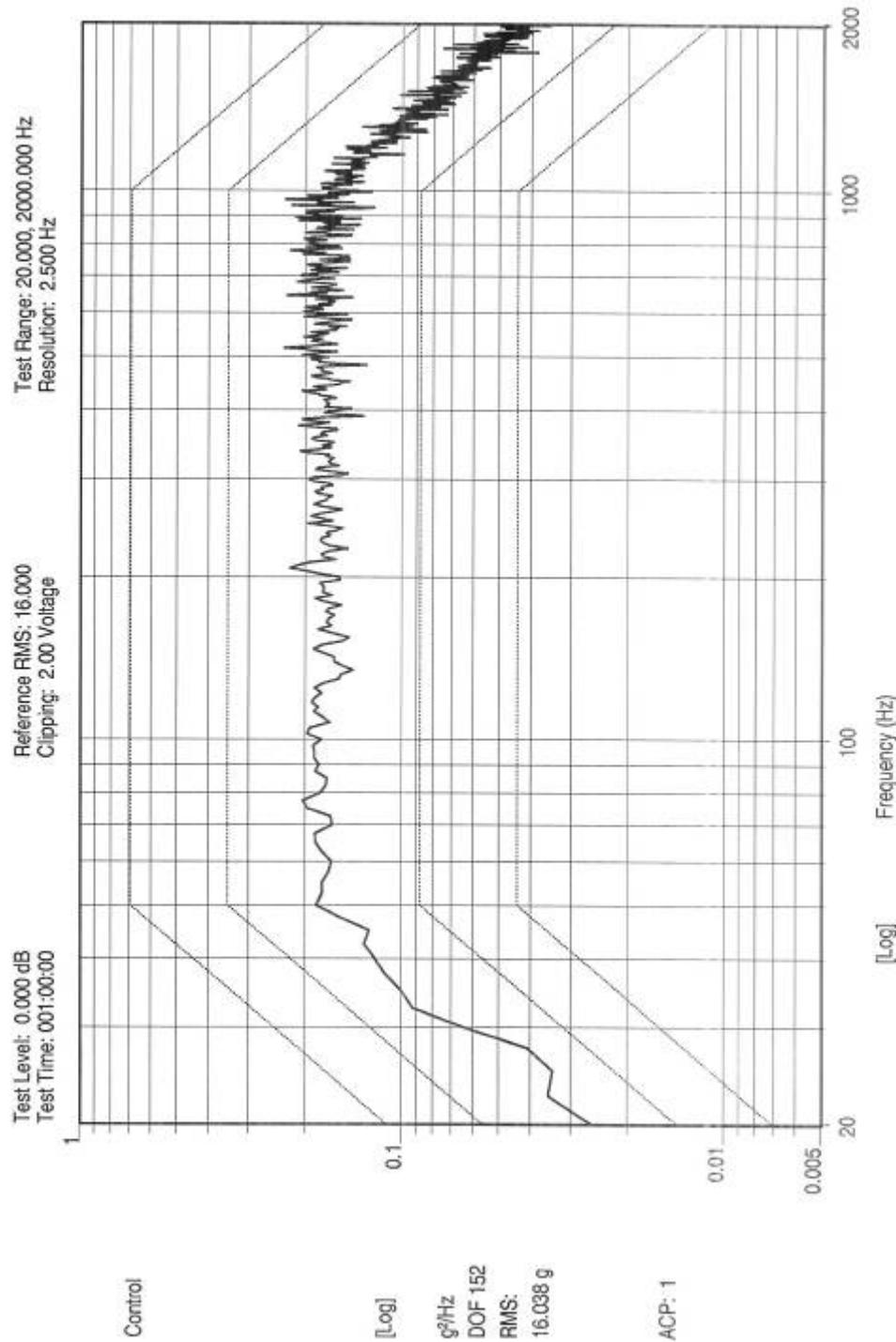


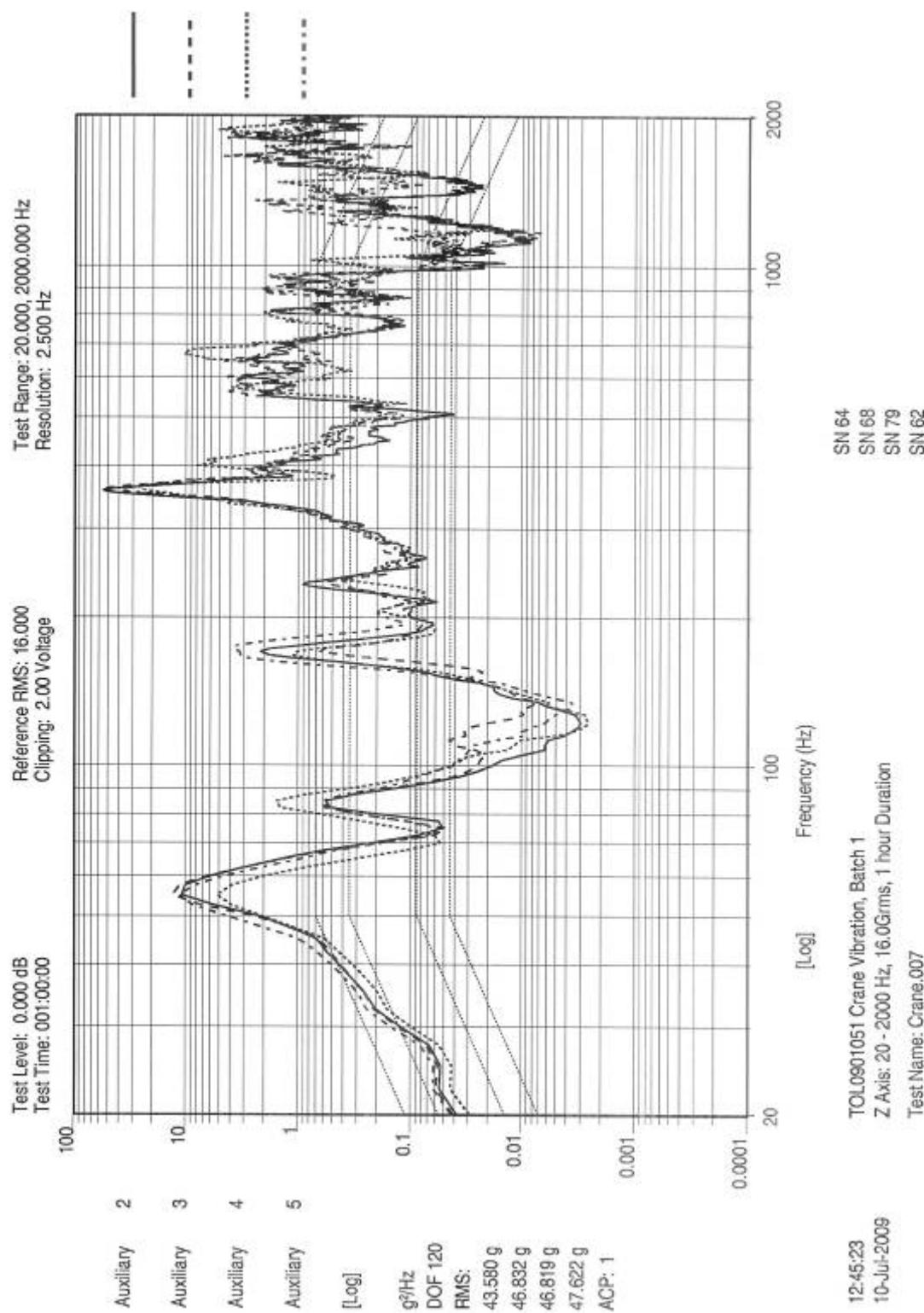


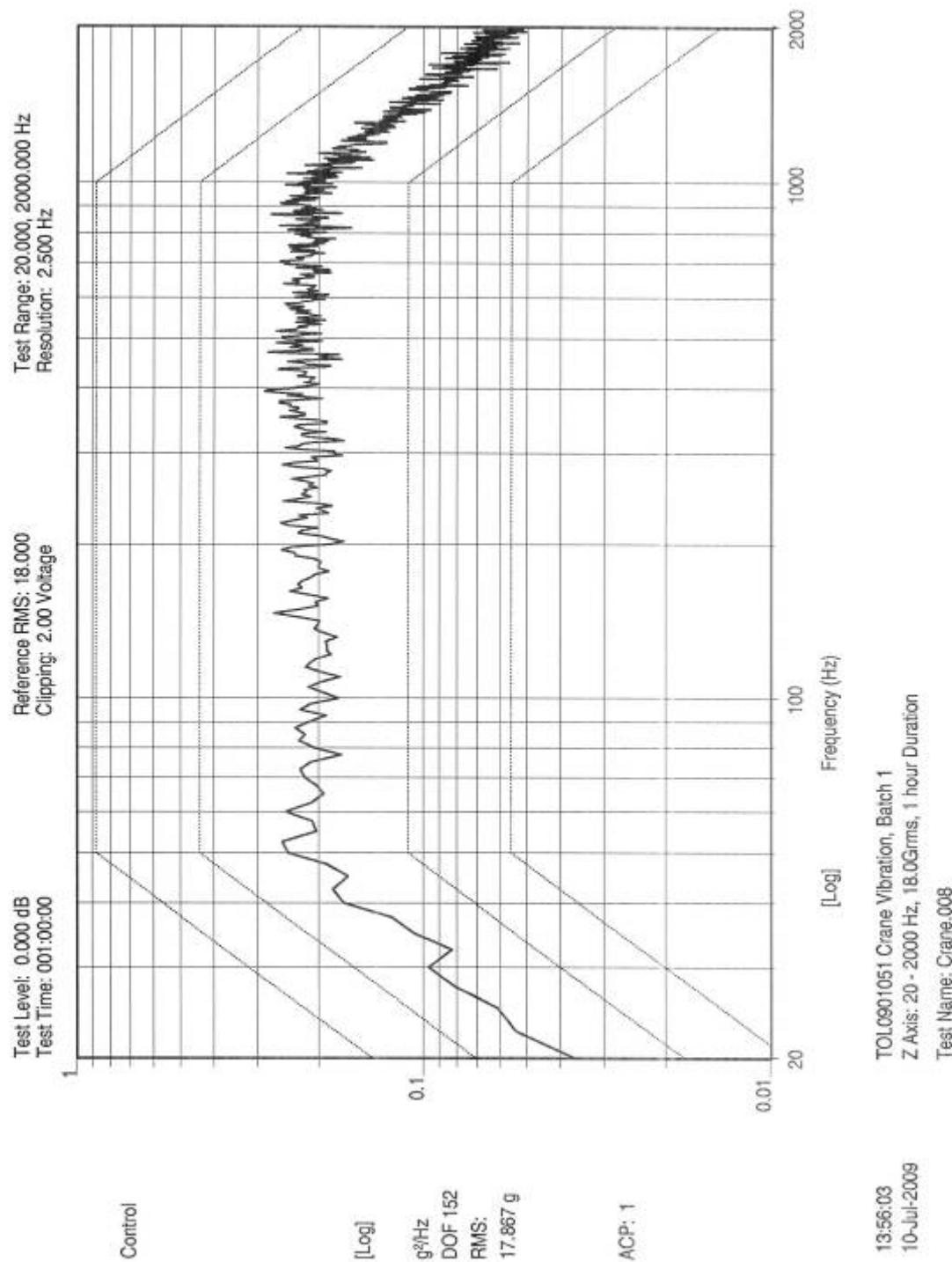
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Z Axis: 20 - 2000 Hz, 14.0Grms, 1 hour Duration
Test Name: Crane.006

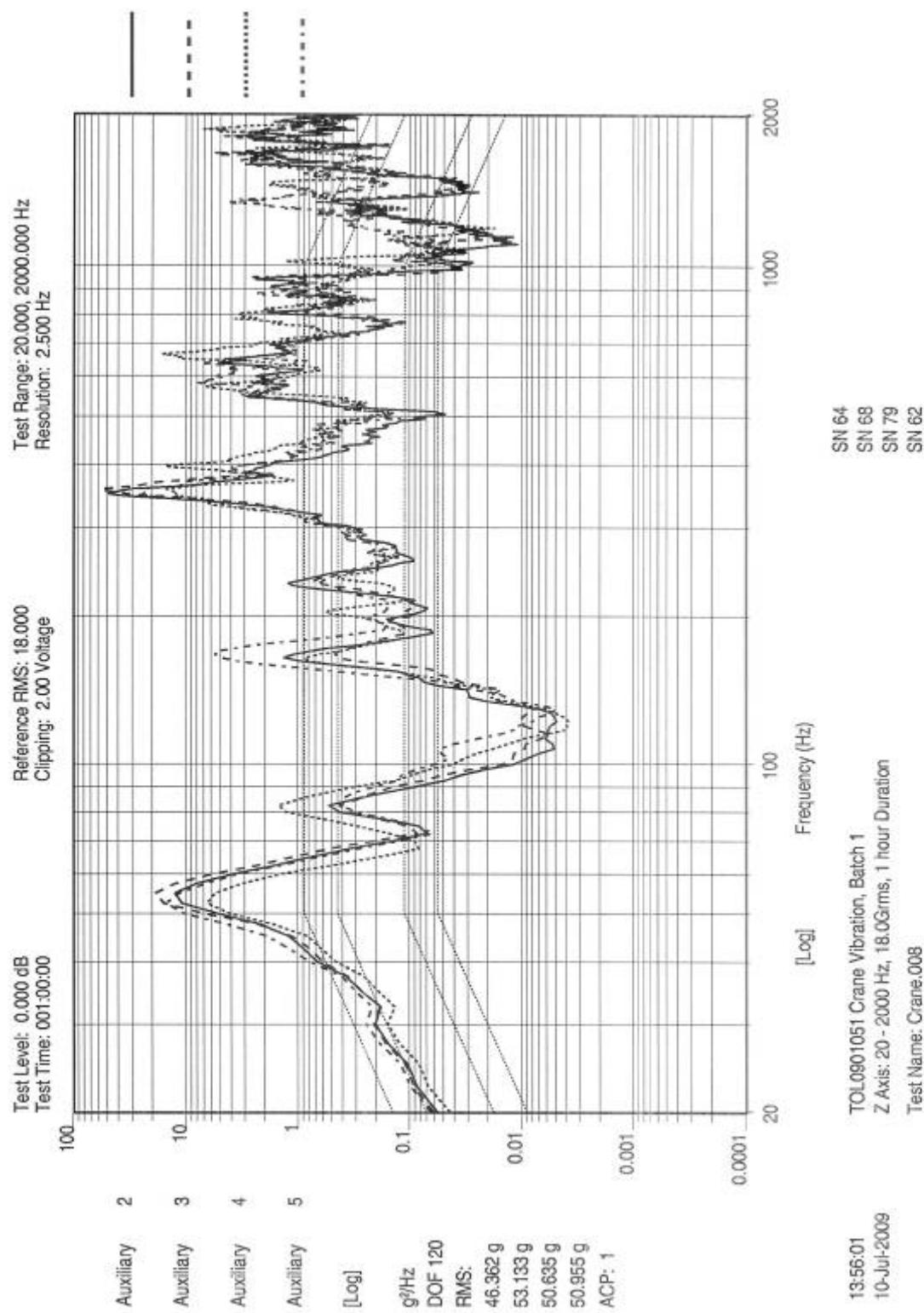
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10-Jul-2009

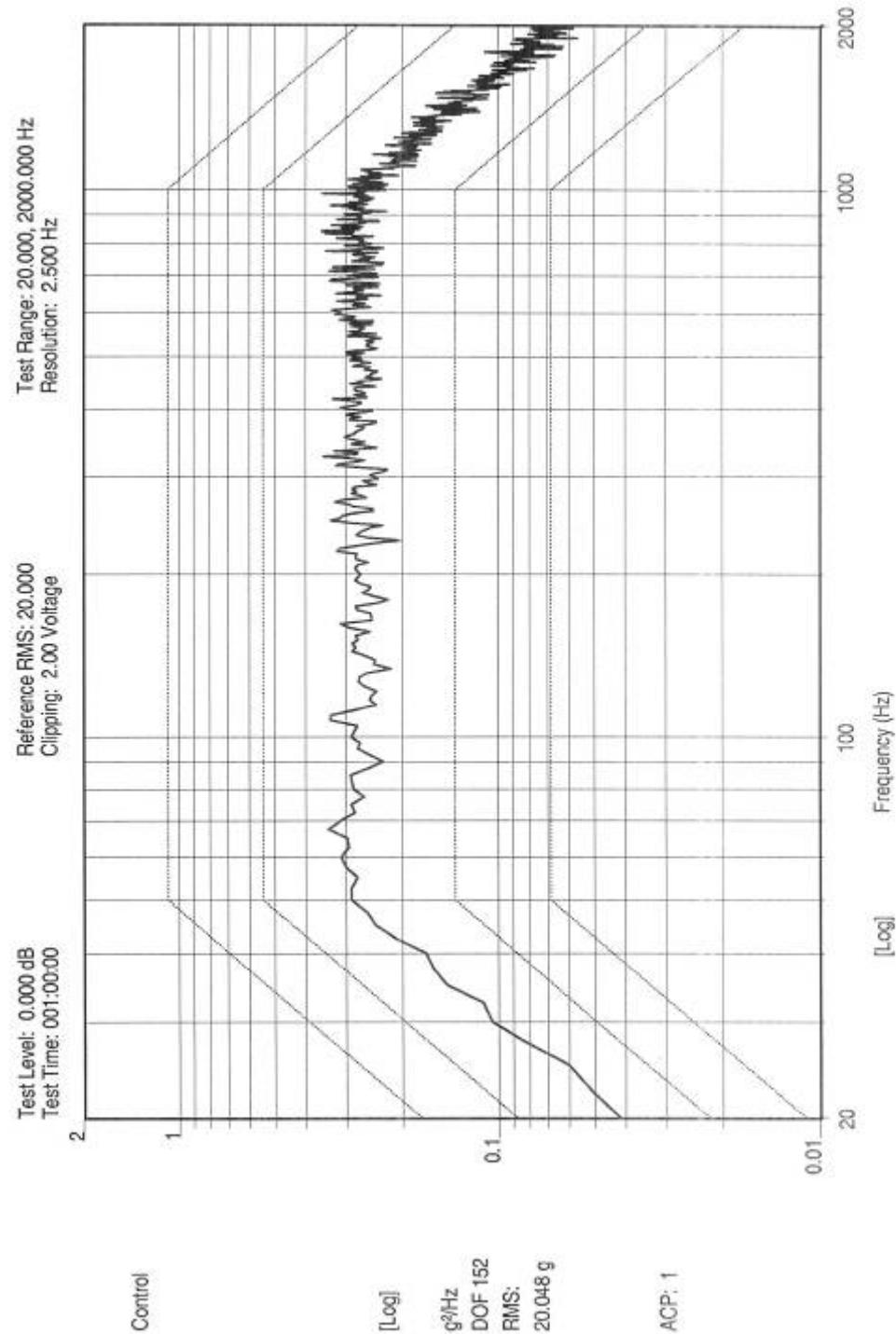






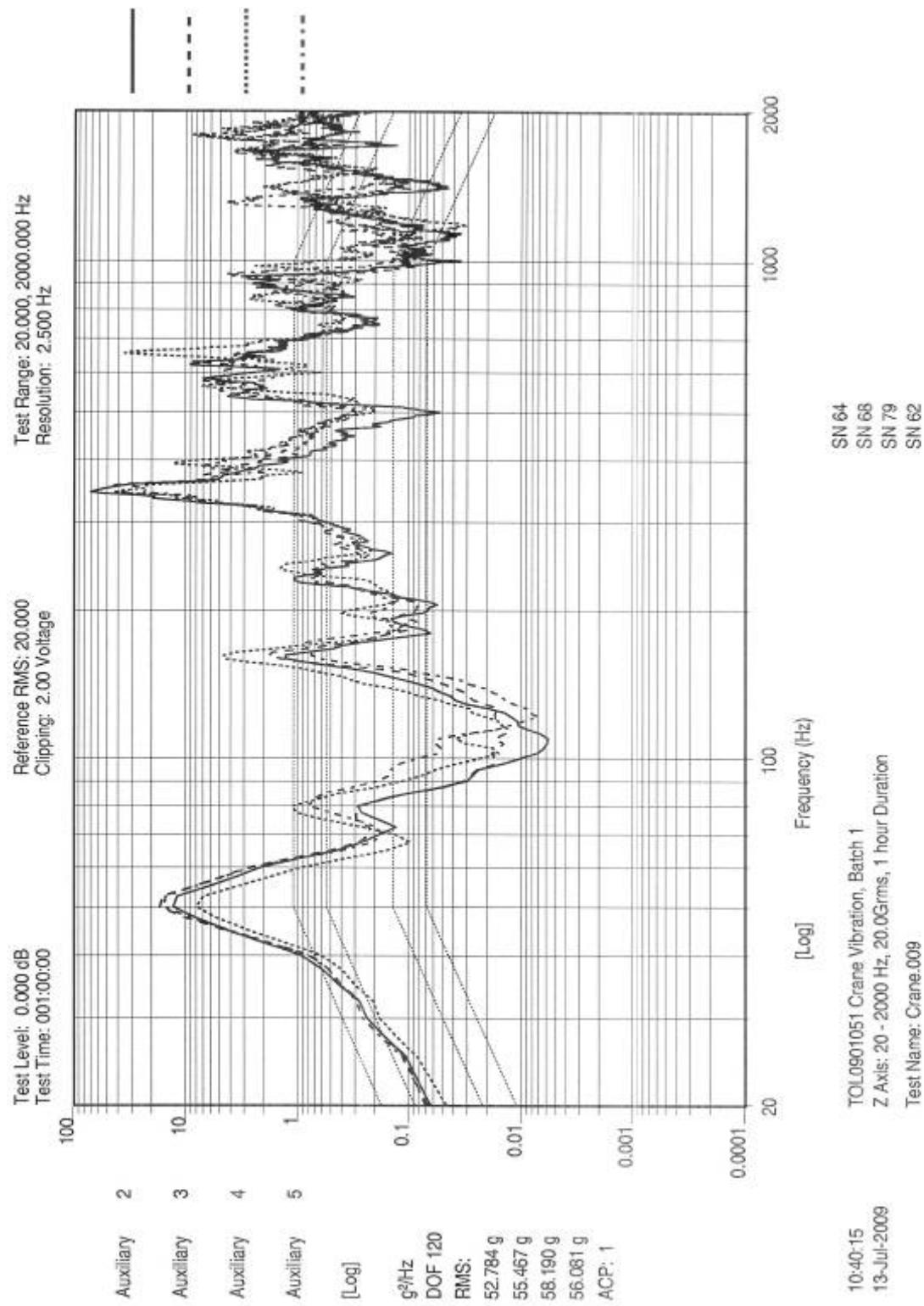


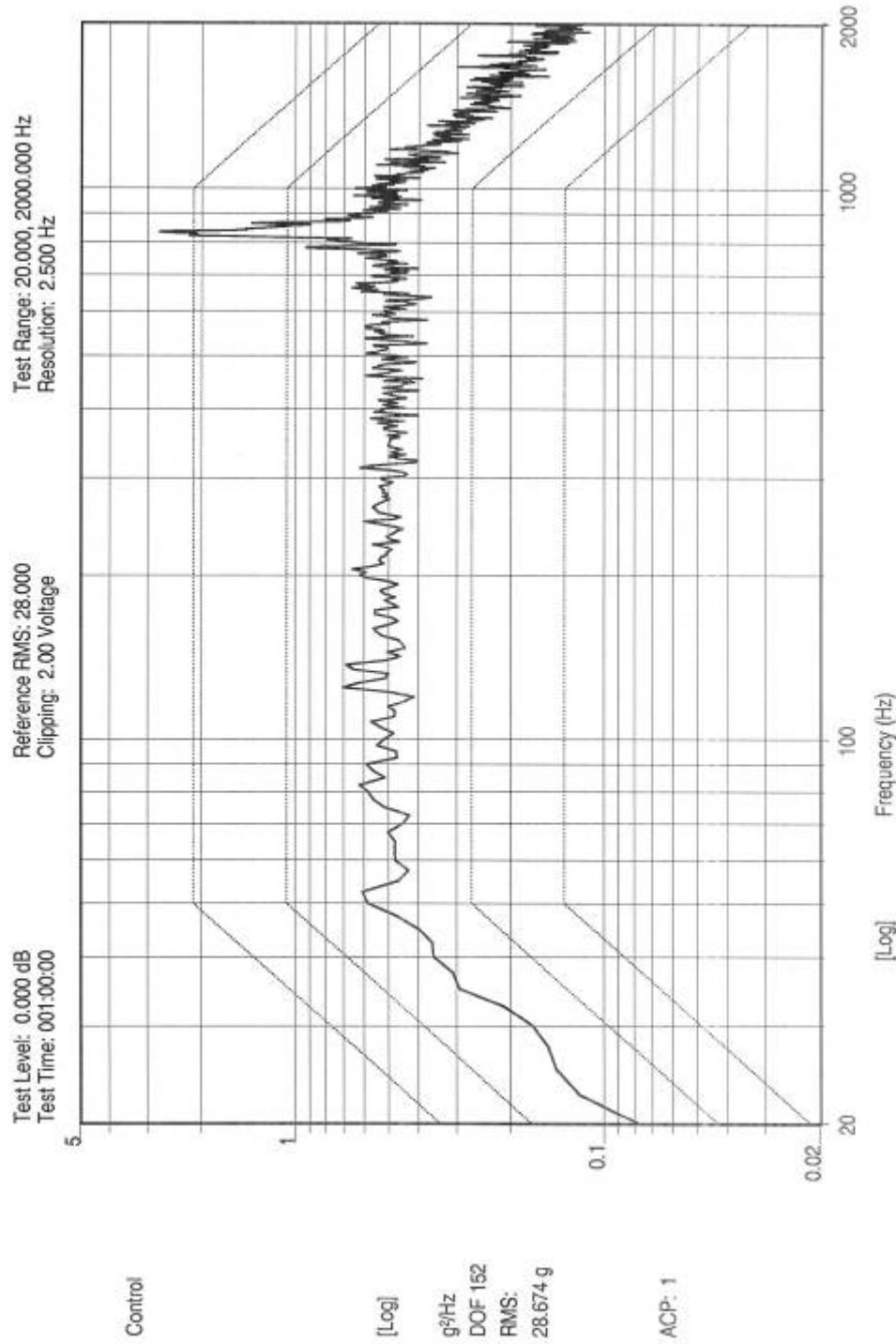


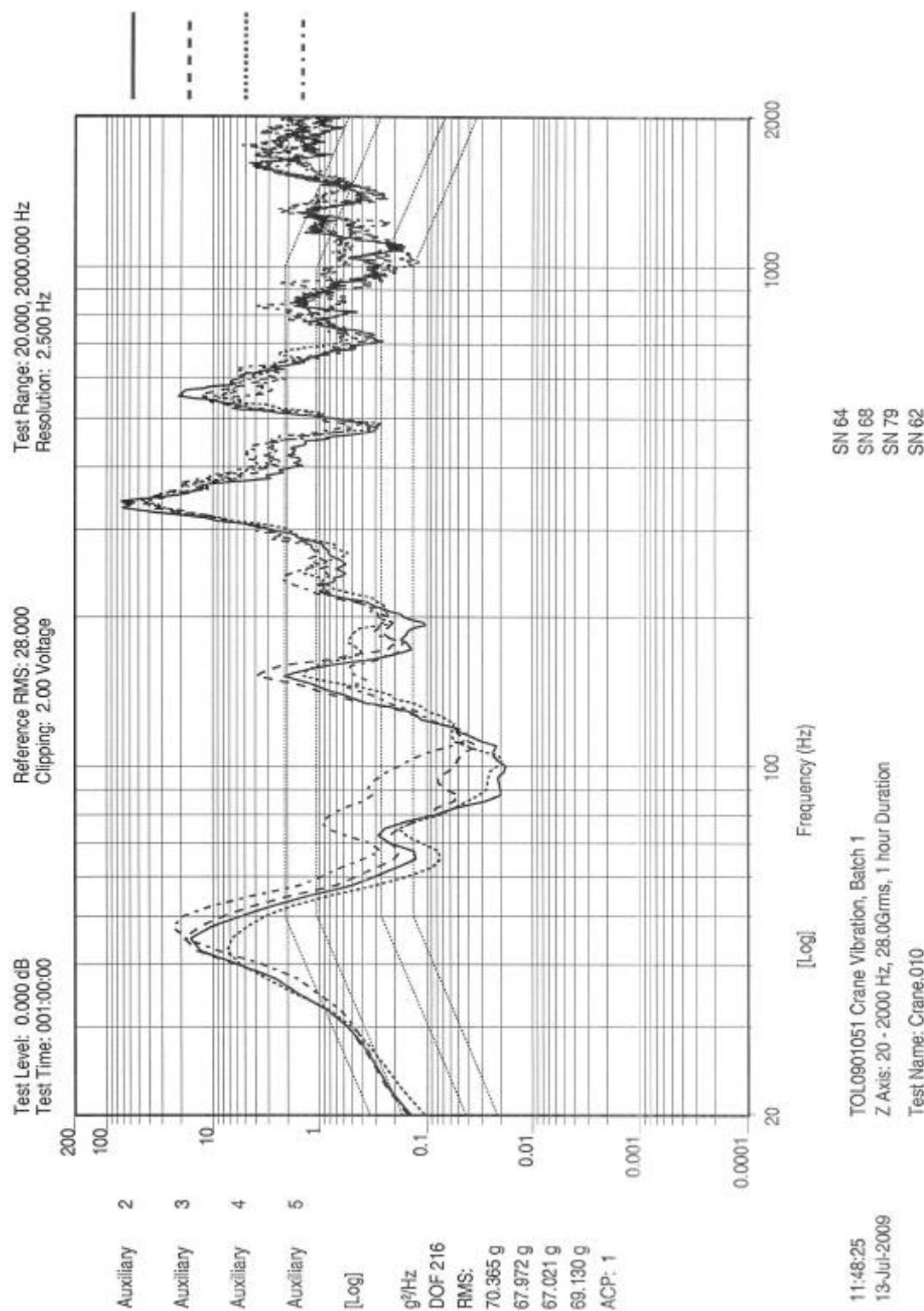


TOL0901051 Crane Vibration, Batch 1
Z Axis: 20 - 2000 Hz, 20.0Grms, 1 hour Duration
Test Name: Crane.009

10:40:13
13-Jul-2009







9.5 Random Response Plots Batch 2:

